BELFAST

University Extension Lectures.

# THE BODY

AND

# ITS HEALTH.

OLLEY & CO., Ltd.

From E. A. Letts
Feb. 1892

# THE BODY

AND

# ITS HEALTH:

BEING A COURSE OF LECTURES DELIVERED UNDER THE AUSPICES OF THE BELFAST SOCIETY FOR THE EXTENSION OF UNIVERSITY TEACHING.

Belfast:
OLLEY & CO., LIMITED, ROYAL AVENUE.

1892.

20177008

PRINTED BY THE CIRCLE CO-OPERATIVE PRINTING CO.,
25 COLLEGE STREET, BELFAST.

# PREFACE.

THE lectures contained in this volume were delivered at the beginning of the present winter, under the auspices of the Belfast Society for the Extension of University Teaching. Six gentlemen, three of them professors in Queen's College, Belfast, and three of them among our best-known medical practitioners, were asked by the Council of the Society to aid them in an effort to diffuse sound ideas throughout the community on some of the more important questions of hygiene. They at once consented, and the delivery of their lectures awakened a great amount of public interest. They were listened to most attentively by large audiences, and the reports of them, supplied by the local press, were widely read. At the close of the course, it was represented to the Council that much good would be done if they were published in a permanent form, so that the views promulgated might be at once widely circulated and carefully studied. The lecturers,

when applied to, very kindly handed over their manuscripts for this purpose, and the result is now presented to the public. Such is the history of this volume, which, it is hoped, may not only prove to many a pleasing souvenir of evenings happily spent in the study of matters of which a most culpable ignorance too widely prevails, but may help to leaven the great and rapidly growing community in which we live with sound and wholesome ideas regarding the great laws of health, and their application to the exigencies of everyday life.

T. H.

Queen's College,
Belfast, January, 1892.

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## LECTURE VI.

# THE CARE OF THE BODY.

BY PROFESSOR REDFERN, M.D. (LOND.), F.R.C.S.L.

OF all the marvellous things in creation a living human body is the most wonderful. Incessantly changing in every part, it yet maintains its individuality through the seven ages, now and then for 100 years, from infancy to mature old age.

It is perhaps the most sensitive thing in creation. A ray of light cannot shine upon it—a vibrating body sound near it—a breath of air blow upon it—but parts of its very structure change, their chemical nature is altered, and electrical currents are produced in them, whilst the utterance of an incautious word may put a sudden end to all its activity, and convert this living sentient being into motionless decaying matter; or reduce a lovely form once animated by the purest thoughts and the most charming intelligence, to an entirely opposite condition, dangerous to any social community.

Truly the life which has been lent to us is a wonderful loan—too valuable to be trifled with—and health, *i.e.*, happy, contented, useful life, maintained in its original purity and buoyancy by rational food, appropriate exercise, and an intellectual and moral atmosphere—one of the greatest and best gifts to humanity.

Unnecessary alarm is both dangerous and useless, but you cannot, you dare not close your eyes and ears to the daily records of suicides to end lives which have been made intolerable. The records of drunkenness and crime by our police and criminal courts, and the testimony of our gaols, and workhouses, and lunatic asylums alike point to the unhealthy atmosphere on which our increasingly dense populations are being fed, whilst we, for the most part, are content with ineffectual attempts to mitigate the results of these disorders of the public health, instead of putting an end to their causes. It is encouraging, however, on the other hand, that reliable statistics show that life has been lengthened—disease ameliorated or prevented altogether, and virtue and happiness promoted—by wise legislation, by the spread of education, and the increasing supply of healthy amusements and stores of knowledge.

The body which I have endeavoured to represent to you as the most susceptible and sensitive thing in creation, is at the same time capable of with-

standing a large amount of ill-treatment, and from this it may be thought that it cannot require much care—perhaps that it is not worth all the care some people spend on it. The thoughtless youthful cry, "a short life and a merry one," frequently applauded at its utterance, is often followed by a large amount of suffering which might have been avoided. The drunkard's periods of unconsciousness are but short in comparison with the many miserable days and sleepless nights he has to spend in the intervals. The fits of indigestion and the racking pains of gout are but poorly compensated by the pleasure of being esteemed fashionable in taking late dinners of many delicacies, and drinking choice wines. The loss of the healthy warmth and chemical influence of the morning sun is scarcely balanced by the pleasure of doing something which poorer people cannot do, sleeping in day-light, and using unhealthy artificial light during a large portion of the year when awake.

The deformed feet and the difficulty of walking of large numbers of persons bear abundant testimony to the injurious influence of the fashion of wearing narrow-toed boots, and such as throw a large part of the weight of the body on the toes, or on the hollow of the sole of the foot, most carefully protected from pressure by Nature's exquisitely beautiful construction of the foot.

The enfeebled heart of tobacco smokers, well known now by the name of tobacco-heart, produces a large amount of suffering, and occasionally failure of the action of the heart altogether. Loss of sight, and affections of the heart, from the use of tobacco, are greatly more frequent now than before the great exhibitions, and the more general following of Continental habits. The miserable attempt to help the tobacco-heart out of its troubles by alcoholic stimuli, so common an adjunct to tobacco smoking, is merely wasting the candle of life at both ends at once.

To the suppression of the natural movements of the body—the greatest characteristic of life—to the conversion of healthy chemical and vital changes into diseased ones by yielding through weakness or ignorance, or both, to other pernicious fashions, I shall have afterwards to call attention.

But what is the need for this painful reference to human frailty—for any mention of matters which concern personal or public health, and have a thousand times over been condemned by the most obvious natural and physiological experience? Why do people *think*? Who are the people who think they will benefit by lectures on health? Are they those who seriously intend to follow any advice they get from persons who have carefully studied this subject, and who possibly see a little more clearly than they the vast extent of the bodily

and mental suffering which result from the great failing of the age—discontent—covetousness—the general desire to be something else—generally the very opposite of what they are? or, do people listen attentively to arguments in favour of a rational mode of life in the hope of finding out their weak points, and with the intention of comforting themselves in the continuance of practices which they expected would be condemned by recollecting some individual case in which the inevitable penalty was long delayed?

It is a great gain that governments and public representative bodies recognised their solemn duty to protect the individuals of a community against each other, and their success is most encouraging. But when they came to the more difficult task of protecting individuals against themselves, they yielded, as elected representatives will always be tempted to yield, to the popular cry for liberty, and failed miserably. Indeed the sad records of dreadful murders and suicides by persons who, but a few years ago, would have been placed under kind curative treatment, show too plainly that in this instance we have retrograded.

Thus it happens that we are still left, to a great extent, to care for ourselves, and we are too apt to conclude that with our own bodies, as we too often falsely call them, we can do as we will.

Present gratifications have too great attractions to be always balanced by considerations of future good, and it requires the experience of mature years to produce the firm conviction that Nature's plan is better than our own.

It is the business of the physiologist to investigate the materials of which Nature has constructed our bodies, and the wonderful phenomena they produce in the condition called life. The more recondite problems of physiology are so intricate as to demand the highest talent, working with the most delicate apparatus of the present age, for their investigation ; but the general and more simple truths already mastered, would serve to augment the sum of human enjoyment to an incredible amount if borne in mind and acted upon.

The body, which seems so firm and capable of resisting injury in games of football and other athletic sports, in pugilistic encounters ; which recovers after serious injuries, involving, it may be, the loss of one or more limbs, and rallies again for a time after the most severe mental afflictions, prolonged fastings, or astounding excesses, is mainly composed of water.

Nearly 3-5ths of it, 58·5 per cent. is water. The solids of the most important part of the brain are only 1-7th of its weight, the rest, 6-7th are water. The kidneys are 5-6ths water. The

apparently firm flesh—the muscles—owe 3-4ths of their weight to water. But well nourished muscles, especially when contracted, feel very hard.

A set of thin india-rubber balls, tensely filled with water, would feel very hard; and muscles consist of a great number of thin walled cylinders, filled with semi-fluid matter, which tends to assume the spherical form when contracting, shortening the cylinders and making the muscle feel very hard.

This more or less fluid condition of muscles is attended with great liability to rapid changes—movement of the particles of the semi-fluid mass—chemical changes involving the destruction of the original compounds, and the formation of new ones; these movements of particles; these chemical actions being, at times, attended by manifest and powerful movements of the whole muscle, a rise of temperature, and the production of electrical changes which can be determined and measured with the greatest accuracy.

Call to mind that the muscles form about half of the weight of the body—recollect that they consist rather of semi-fluid than of solid living snbstance, undergoing constant movement of its particles, constant chemical change every momont that its life lasts. Streams of blood charged with oxygen are incessantly circulating about

each little cylinder or muscle-cell, and in its circulation in contact with the muscle, its composition is changing too; it is incessantly losing oxygen which the muscle retains; it receives carbonic acid which the muscle gives up; it carries the materials of which the substance of the muscle is made up —the food of the living muscle in fact—and it brings these matters away again from the muscle after they have been used by it, but in different chemical combinations from those in which they were first applied to the muscle.

Can you contemplate these changes in every individual muscle-cell in your bodies without being struck dumb with admiration at the method of their maintenance, as phenomena of life--incessant change, incessant motion—changes and motions of definite kinds, of measured amounts, every moment of our lives? Can you believe that to maintain the health of every one of the many millions of muscle-cells in our bodies, it is necessary that the living faculty of each shall enable it to take from the blood just such a kind and such an amount as it needs of the materials flowing in that stream of blood—that it must give up to the blood in a given time the particular kind, the proper amount of the waste materials produced in it?

And what shall we say of the blood itself—the living fluid carrying millions on millions of par-

ticles, soft and jelly-like, continually changing like the soft substance of muscle, influenced by the kind and quantity of every meal we take, and yet maintained of a definite healthy composition under all ordinary conditions? Have you nothing to say of the beneficence of the provision of the healthy appetite of him who labours, of the grateful feelings engendered by the thought or the act of appeasing this delightful sensation, of the guidance which it affords as to the proper character and quantity of food, of the natural production of different and suitable kinds of food in different climates? And then think of the folly—not to say the wickedness—of the voluntary outrages most of us are daily committing, both as to the kind and the quantity of our meat and drink, recollecting all the while that what we take for food becomes blood in a few hours, and that this blood is at once and continuously circulated, not merely about every muscle, but about every corresponding cell of the brain and every organ that we have.

When we find that alcohol taken into the stomach is absorbed with almost explosive rapidity, and immediately afterwards can be distilled from fluid found in the ventricles of the brain, is it any wonder that it at first exalts the functions of the brain, often to a dangerous extent, and then paralyses and abolishes them? We call the man

lying in the gutter in this state dead-drunk, because he has chosen to abolish, for a time at least, his proudest characteristics as a man, his Intelligence and his Will, as completely as if he were dead; or we say he is beastly-drunk, because he has reduced the being possessed of the highest created intelligence to the level of the brute creation.

Let us return to our muscle. We find it consists of two distinct sets of parts—the semi-fluid contractile contents of its muscle-cells and the parts connected with its maintenance and control—the red and white blood-vessels which supply it with food and means of drainage, and the nerves which evoke its contractions as they are required.

You must please to apply what I previously said about muscle to its state of rest—physiological rest—a state, however, of constant activity and change such as happens in every living thing. And now we look to what happens when muscle is stimulated to contract by an impulse travelling along its nerve, evoked by pricking, or pinching, by heat or cold, or by an electrical stimulus applied to itself or to its nerve, or again by the stimulus of the Will operating through the nerve of the muscle.

Two sets of events happen,—one upon the blood-vessel, the other on the proper tissue of the

muscle-cells. The blood-vessels instantly dilate and supply the muscle with an enormously increased quantity of blood which circulates through it so rapidly that there is not time for it to be converted from red into black blood, as happened previously; and the muscle contracts, its shortening producing the movements we observe in the limbs or organs, whilst at the same time there is an explosive decomposition of the tissue of the muscle, attended by an electrical change, the production of heat and the discharge of the products of decomposition, carbonic and lactic acids.

If stimuli be applied too often to a muscle it becomes exhausted and will no longer contract; if the products of decomposition be not removed by the blood stream, or if they be supplied to it artificially, it will not contract. Time is an important element in all vital actions. A tissue can only do a certain amount of work in a given time; if not called upon to act at all it wastes away and becomes permanently useless, and if greatly exhausted by severe stimuli too often applied, it may be so far injured that it may never recover.

Exercise of muscles or brains promotes their growth and vigour; excessive action of either may produce permanent injury.

I chose to illustrate the condition and action of a living body by reference to muscles, not because there is any difference in the general conditions of

their life and action as compared with the other parts of the body, but because the facts are easy to determine in connection with them, and because they have been determined with what I may fairly call absolute accuracy.

The rest of the body is similar in its nature and action. The very bones are full of little cavities occupied by jelly-like highly-susceptible masses, whose incessant changes are as necessary for the life and maintenance of bone in health, as the changes in the parts of which we have been speaking are for them.

The sense organs, the skin, tongue, nose, ears, and eyes are made up of little microscopic blocks of soft sensitive jelly-like material, always changing, but when stimulated, changing more rapidly and completely, the chemical changes being attended by electrical ones, by the starting of nervous impulses to inform us what is going on, by more rapid circulation of a larger quantity of blood through them than at other times, and by consequent exhaustion to an amount proportionate to the stimulation.

You all know that rapidly-repeated stimulation of the organs of taste and smell destroys their power of distinguishing one substance from another—that the eye is paralysed temporarily, and at times entirely destroyed by exposure to the direct rays of the sun, the electric light, or

the light reflected from the surface of snow, and temporary or permanent deafness often results from exposure to the noise of cannon for many hours in succession.

Our senses are of inestimable value—their organs are of great delicacy—their most effective action only takes place under definite conditions; in proportion to their value and their delicacy they require great care. Yet three out of the five senses (smell, taste, and sight) are often sacrificed by the use, I shall call it abuse, if you like it better, of a single noxious agent—tobacco.

Observe—a muscle, an organ of sense, a living tissue of any kind, for the incessant activity and change, characteristic of its life and health, is supplied with a living, incessantly changing stream of blood, in measured quantity, under a definite pressure, to suit its activity at different times. And the blood, really our food and drink changed by the process of digestion, is maintained in a healthy person at a healthy standard of quantity and quality. Blood is the great reservoir and source of colour in the body. How often the healthy colour varies in different persons you can see at once by looking at their cheeks and lips. And if you inquire into their habits and modes of life, the kind and quantity of their food, their periods of taking it, the variable

amount of care they take in masticating it and mixing it with the digestive secretions, you easily establish a close relation between healthy food and healthy methods of taking and dealing with it on the one hand, and the healthy or unhealthy conditions of the blood on the other hand. And you may be sure that a healthy condition of blood-supply is a necessary attendant on a healthy, vigorous, happy condition of both body and mind.

Taking this element of colour of the blood alone as a guide, and it is a most important element, a very certain guide, you cannot fail to notice that the pallid, the yellow, the greenish and dusky hues of cheeks and lips that you see are far more common in one sex than the other; and you can judge whether there is not a corresponding difference in the attention they pay to regularity of hours, the selection of appropriate food and clothing, and to the continual occupation of the entire being in some intelligent, useful, happy pursuit.

Waste, the inevitable attendant on the incessant restlessness and change of living tissue must be compensated by as incessant introduction of new matter. An adult remains in perfect health and of the same weight from day to day when his food equals in the character and weight of its elements those of the daily discharged excreta. I think it is rational to suppose it best that this

meeting of waste by supply should be attempted whilst the waste is going on most actively, *i.e.*, during the day, not during the night, when both mind and body should be in comparative repose. The conversion of food into blood is at first physical and chemical, the effect of secretions produced by living organs, such as the salivary glands, the stomach and intestines, the liver, pancreas, &c. A chemical re-agent can only exert its influence on a certain definite weight of matter; a living organ can only produce a certain amount of secretion, according as it is stimulated, and in a given time.

The secretions are not poured out unless there is food to be acted upon. Their quantity is proportionate to the amount of food present or to that which is required by the body.

Too small a supply of food means loss of weight and impairment of energy, both of body and mind, as too often happens in the poorer classes; our farm labourers and factory girls, for example, who instead of taking as they formerly did, the sensible invigorating diet of oatmeal porridge and buttermilk, try in vain to sustain themselves on the more fashionable diet of tea and thin bread and butter, and then to help them to get through the day, they resort to alcoholic stimulants. From the physical and moral effects of these they cannot escape.

A great surplus of food which there is not time to digest, or the taking of indigestible articles, means the exposure of these matters to the moisture and heat of the body, to fermentation and putrefaction, the growth of germs, and the disengagemet of offensive gases. Thus arise the painful distention and all the other evils of the interesting physiological disturbance, styled indigestion.

The organs of digestion—stomach, intestines, liver, pancreas, and spleen—are similar, in this particular to the muscles, we have considered so fully. Whenever they are stimulated by the presence of food, they receive an amazingly increased quantity of blood. How much they are capable of holding, it is difficult to believe; it depends on the release of their vessels from nervous control. If their nerves be entirely cut away, so much of the blood of the body flows into the digestive organs that there is an insufficency left in other parts, and the animal dies, as if the blood had been drawn from the body into a bowl.

Three of these organs, the spleen, stomach, and liver, the latter by far the largest of them, lie under the lower ribs where they are accommodated in the widest part of the moveable wall of the great cavities of the body. They are separated from the heart only by the very thin partition of the diaphragm, and when distended, as for

instance, when a bowl of soup is taken, the heart, in states of disease, is often overcome by the pressure; it fails to act and the person dies suddenly. Such persons are always advised to avoid great distension of the stomach, etc., to take dry diet. As long as they act on this advice they experience great relief.

And in inflammation of the investing membrane of the heart, vomiting is an early and important symptom from the proximity of the stomach and heart.

Further, when these organs are largest, they are also in most active movement. All the time, 3, 4, or 5 hours of digestion in the stomach, the organ keeps the food in continual movement from one end to the other on the surface, and back along the middle so as to bring every part of the food in succession in contact with freshly secreted gastric juice, and as the food is digested and passes continuously beyond the stomach, the 25 or 27 feet of intestine move continually to propel it regularly along.

Probably some of you, not sufficiently interested in the wonderful movements of the walls of the chest and abdomen, to have watched them in your own persons, have had your attention called to them by a wax figure in Madame Tussaud's museum, in which the natural movements are imitated by well contrived mechanism.

In the earlier lessons in singing, young people are taught to practice the expansion of the lower, the widest part of the chest, that they may make use of the greatly larger volume of air thus introduced; and every mode of exercise which promotes the process of respiration in the lower most voluminous parts of the lungs; trapeze exercises, the use of dumb-bells, even cheerful conversation and laughter are healthful, because they promote and even increase these ordinary healthy movements.

And whatever interferes with them as certainly promotes disease, sometimes of the lungs, frequently digestive disorders from compression of the stomach or bowels, and interruption of their natural enlargement during digestion, and of their movements, or when on the taking of food there is not room for the stomach to expand and elevate the soft elastic wall covering it, it enlarges in the upward direction, raises the diaphragm, compresses the heart, and produces gasping and restlessness, from the difficulty of circulation, and at length, suspension of the heart's action in a fit of faintness.

What frequeutly happens is this. You sit down to dinner with a number of perfectly healthy people. Suddenly your attention is arrested by one who, instead of being invigorated by the repast, presents an increasing pallor of lips and

cheeks with every morsel she swallows, you notice that a little relief is obtained now and then by slight shifting and change of posture, but as time goes on and more food is taken the restlessness increases and is succeeded by gasping, the individual being compelled to leave the table or requiring to be carried out. The on-lookers are aghast at what has happened, they cannot imagine what has caused the sudden change; they administer draughts of cold water and alcoholic stimuli, only with the effect of making matters worse, when suddenly the stomach relieves itself of the moderate quantity of simple healthy food which has been taken, and immediate relief is obtained. The intelligence returns, the colour of the lips and cheeks is regained, the heart resumes its healthy pulsations, and the individual seems as well as other healthy persons. The difference between them is that her stomach cannot expand on the introduction of food, without compressing the heart and stopping its action, whilst the movements of her chest, essential for respiration, have been reduced to the least amount consistent with the continuance even of a miserable life.

The number and variety of the arrangements in the body to meet contingencies are almost infinite. Taste, smell, and healthy appetite guide in the selection of proper food. If improper food has been taken, or if it be in excessive quantity,

the stomach frequently rids itself of it at once; if not, the irritated alimentary canal performs a similar office, and speedily restores a healthy natural state. We are exposed to numerous causes of disease of our various organs—for instance, our lungs, liver, and kidneys; but Nature has given us a large reserve allowance of each; for instance, two-thirds more lung than is needed for respiration at any one time, so that disease of any organ may affect a large portion of it and still leave a sufficiency to discharge the function until the diseased part has time to recover.

One great use of the nervous system is to regulate the amount of action of each organ so as best to contribute to the welfare of the rest of the body. Every beat of the heart is regulated as to its succession and force by a distinct operation of nervous impulses. Think for one moment what this implies. More than a hundred thousand double contractions of the cavities of the heart take place every day in every one of us; more than thirty-six millions of them every year, and yet you might examine hundreds of persons without detecting, perhaps, in one of them any irregularity of the rhythm of these contractions; so essential are they to our health and comfort; so perfectly are they presided over by our watchful nervous system, which, in the part employed for this purpose, never sleeps.

Yet this beautifully adjusted, continually moving organ is influenced by daily events happening around us. Its movements may be suddenly arrested by the abrupt communication of unwelcome intelligence; and the failure of impulses through the exceedingly delicate nervous threads of the heart, brings all the other phenomena of life to an end.

You have all heard, if you have not felt, that the movements of the heart, of which you are scarcely conscious in the normal state, go pit-a-pat on the mention of some interesting name; and you have seen the influence of this simple event exerted upon the extensions of the heart's tissue—the blood-vessels—charmingly illustrated by the crimson blush of the cheeks. Both these, and an endless variety of other results in other parts of the body, arise from the operation of certain of the myriad automatic mechanisms in restless activity every hour of our lives, and always ready to manifest their presence by unusual activity on other than ordinary occasions.

Exactly similar are the operations on two successful merchants, who on going to business in the morning find themselves ruined by some pecuniary failure. One returns home deeply jaundiced; the other, unconcious of this world's vast wealth of enjoyments, and that it offers pleasures far more satisfying than heaping up

vast piles of coin, seeks some unfrequented place where he ends his existence.

Then comes the coroner's inquest, and the verdict of temporary insanity, with its miserable consolations for the afflicted relatives and friends, and the approval of what is called the humane part of mankind.

Why does not the legislature offer the consolations of verdicts of moral insanity in the infinitely more numerous cases in which life is sacrificed in criminal disregard of the most tender maternal instinct by the resolute refusal to helpless infants of the food which Nature herself has provided for them? Not only has Nature provided the only proper food for the period of infancy, but in doing this she has furnished the most certain means of promoting the health and happiness of the mother. Health, happiness, even life itself, give way before the demands of fashionable society.

A little lower in the scale, the want of warm and suitable clothing is a fertile cause of the great mortality in infancy. A very useful lesson on this point may be learned by the simplest observation of the nests of rabbits and birds.

Is it here that lectures on public health are required? Does any one affirm that ignorance is the cause of this fearful sacrifice of human life? The whole epidemic diseases together; the effects

of deficient supplies of water and proper drainage are not to be compared with the wholesale destruction of human life and health in infancy—childhood.

But then you see supplies of water and drainage are the functions of public bodies of our own representatives whom we are so proud of having elected. They give us no individual trouble or anxiety whatever; even the necessary taxation is paid most cheerfully, and is, perhaps, frequently regarded as the best evidence of the discharge of the solemn duties we owe to ourselves and society.

I dare say many of us look upon our philanthropic efforts to maintain and comfort the thousands of inhabitants of our workhouses and gaols, of our deaf and dumb, our blind, and our lunatic asylums in much the same light, and whilst approving in the highest degree of every attempt to relieve and comfort such persons, I think we commit a grievous error in not looking more carefully into the causes which brought them into existence; in not recognising the great influence of heredity; preventing certain marriages and discouraging others; checking the drunken excesses and debaucheries of married persons especially at the commencement of married life.

Here again the cry for individual freedom in a social community runs entirely riot, as has been well shown in a valuable article by my old friend

and former student, Dr. Samuel Strahan. We are probably more proud than we should be of the two million evidences* we have of our freedom to manufacture whiskey and tobacco for the civilised world.

Whether sudden deaths from failure of the action of the heart are more frequent now than formerly, or whether they appear to be so because of their being brought more prominently under our notice by the extended daily press, it seems impossible to judge. But it is interesting to the physiologist, if not important to every one, to have found how numerous and subtle are the influences which regulate the action of the heart—that a single drop of a solution on a frog's heart will suddenly stop its action, and that others will quicken it, or if previously applied, prevent its being stopped—that a little pressure on a certain part of it will cause it to stop, and the release from pressure enable it to go on as before—that an electric stimulus, though entirely different from the ordinary nervous impulses acting on the heart, will nevertheless, if applied to one of its nerves slow, or stop it; if applied to another will quicken it—and that when a frog's heart, which, when removed from the dead body will continue to

* Belfast pays two millions sterling of Customs duties annually for whiskey and tobacco alone.

contract with its regular rhythm for hours or days, has ceased to contract, it may be made to resume its regular rhythmical contractions for a considerable time by passing a constant current of electricity through it, though the stimulus of the shock of an induced current, *i.e.*, of electricity much higher tension will cause only a single movement instead of regular rhythmical action.

This time-regulated action of the cavities of the heart in their appropriate succession, to drive the blood along and maintain the current in a constant direction with a determinate amount of force, cannot but give rise to very solemn views of the nature of living actions, to reverence for the author of such movements. Some animals have a cavity or sinus which receives the blood as it comes from the body to the heart. This is contractile, and its contraction drives the blood into the next cavity, the auricle ; this is succeeded by a contractile ventricle, and this again by a contractile arterial bulb, all contracting in regular succession ; thus—sinus, auricle, ventricle, bulb ; sinus, auricle, ventricle, bulb, always in rapid, regular succession, as long as the life of the organ lasts.

You stand and reverently admire this amazing manifestation of living energy, continually, regularly, rapidly working to effect a determined purpose ; and then you may apply a stimulus and

produce a profound change—a regular rhythm, but in reverse order. Now, the contraction follows this course, bulb, ventricle, auricle, sinus; and bulb, ventricle, auricle, and sinus again. The little world is entirely upset. But for valves the blood-stream would flow backwards. The mechanism instead of promoting the life of every part is now destroying it. How small the cause—how profound the result!

Is this an organ you dare trifle with. Are these ever-watchful, automatic movements such that you dare try to regulate them by your will. It is related that one individual acquired such power of voluntary control over the movements of his heart that he could stop them when he chose, but on one of these occasions the heart refused to start again. Another person could slow the action of his heart by pressing on a nerve in his neck. Many interesting observations on the effects of electrical stimulation were made on a person whose breast-bone was so deficient that the heart was covered by little else than membrane. And various medicinal agents exist which will check too rapid or frequent movements of the heart, or invigorate a heart contracting too feebly.

But such experiments on the living heart are highly dangerous; medicines which affect the movements of the heart should never be adminis-

tered except under the watchful eye of a skilful physician. And if I have not said sufficient already on the evils of tobacco, I would now warn all great smokers that they may come to mistake the enfeebling action of tobacco on the heart for what they call its soothing influence during the rough discipline of daily life. The early, almost insensible, influence acquires strength day by day, until it becomes a tyrannous power, demanding obedience, and tormenting its miserable victim until he has satisfied its demands. Is this a fitting use to make of high intelligence and will ? Is it the sort of health and comfort we spend so much time in striving after ?

Or is it not rather more akin to the condition of the Eastern slave to opium whose only remaining excuse is that he is miserable without it—come what will he must have it.

We may, perhaps, claim to be free from extensive indulgence in opium, but let us take care that we are not led astray by its more elegant, more fashionable alkaloid, morphia, or by the insidious influence of chloral, or such-like agents, much more generally indulged in now than formerly.

The knowledge that there is a form of insanity, characterised as chloral insanity, should be sufficient to warn us against it. And, if the nausea produced by morphia taken into the stomach can

be got rid of by injecting it under the skin, it must never be forgotten that its continued use is permanently injurious, and that, like every other habit, each indulgence makes the next one easier, until at length resistance is hopeless.

A brain-cell, issuing the mandate of the will to perform some action, is changed in its tissue exactly as the substance of muscle changes when it contracts; every intellectual or moral act is attended by a corresponding change. Thus, the brains of different individuals become as different as their modes of life, and as the multiplication of individuals is nothing more than the separation of a piece of tissue from the old body, carrying with it all its properties, it follows that there is a hereditary descent of all the original and acquired properties from the parent to the child. Many a man who would brave the effects of some physical or moral injury of his own body would shrink from the infliction of such injury upon his children, as the most cursory observation proves to happen from day to day.

Thus, not only are the effects of want of care of the body, and of injury of its various parts and organs, attended by inevitable disorders of health, destruction of comfort, and the possibility of enjoying life; but as every new life represents and continues the old one, these punishments inevitably descend even to the third and fourth generation.

If, in calling attention to failures in the care of the body which I believe to be seriously detrimental to individuals and to society, I have said any unnecessary word, I crave indulgence on the ground that the study of living actions and the devotion of my life to teaching the operations of Nature in man's body, have made me jealous in defence of her methods, and fearful of withholding, for mere personal considerations, any portion of what I believe to be the truth.

# THE CHANNELS OF INFECTION.

By THOMAS SINCLAIR, M.D., F.R.C.S., Eng., Professor of Surgery, Queen's College, Belfast.

THOSE who have read Addison's essays in the *Spectator*, may remember his ingenious description of the body in the essay upon labour and exercise. He wrote—" I consider the body as a system of tubes and glands—or, to use a more rustic phrase—a bundle of pipes and strainers, fitted to one another after so wonderful a manner as to make a proper engine for the soul to work with. This description does not only comprehend the bowels, bones, tendons, veins, arteries, and nerves, but every muscle and every ligature which is a composition of fibres, that are so many imperceptible tubes or pipes interwoven on all sides with invisible glands or strainers." * * * * " There must be frequent motions

and agitations, to mix, digest, and separate the juices contained in the body, as well as to clear and cleanse that infinitude of pipes and strainers of which it is composed, and to give their solid parts a more firm and lasting tone."

This crude conception of Addison's is by no means wide of the mark, and I shall ask your attention for a moment to two great systems of tubes in the body, which serve as internal channels, and through which any poisonous material, introduced from without is rapidly carried to all parts of the organism.

First, the red blood-vessels—The pure blood pumped by the heart into the arteries, is carried by them to all parts of the body, and then brought into intimate relation with the organs and tissues by the finer capillary vessels. After the blood has given up to these organs and tissues the new materials they demand, it returns by the veins to be sent to the lungs for purification.

Such an unbroken system is paralleled by the water-supply and drainage of a large town. The pure water mains representing the arteries; the domestic arrangements of pipes and taps, the capillaries; while the veins are analogous to the sewerage system by which the waste materials are removed to the sea, whence purified by evaporation, the water returns again.

Next, the white blood-vessels or lymph-vessels.

I wish more particularly to refer to this lymph system and its circulation, for its existence is not so well known, and is often overlooked.

The lymph-vessels have such ill-defined beginnings, such imperfect boundaries or walls, that it is no wonder they formerly escaped observation. They are more numerous than the red blood-vessels; and if we try to find a parallel in Nature for the lymph circulation, so as to render a conception of it more vivid, we may compare it to the movements of rain-water upon a mountain. Imperceptibly the rain upon the hill percolates between the particles of mould or sand, as mere soakage, then through chinks and crevices in rock and gravel, until, by and bye, it emerges in springs and rills; these in turn converge to form larger rivulets and brooks, and, by repeated confluences, the terminal river. Not one of these tiny channels is like another, and the general arrangement is so variable at different parts of the earth's surface, that it supplies a parallel to the lymph-system of our bodies, the circulation in which is quite comparable to soakage or absorption upon the hill-top.

The lymph-vessels carry their lymph to little oval bodies called lymphatic glands; and having passed these little stations, the current flows on to mingle with the red blood stream and become lost in it.

When a person is vaccinated, a little vaccine

poison is scratched in through the outer skin, which soaks into these lymph channels that abound in the skin. Besides producing, in two or three days, the skin inflammation which ends in the pock, the poison causes some painful hard swellings in the armpit. These are the lymph glands that have received some of the poison, and through them the virus passes into the general circulation, giving rise to the feverishness which accompanies vaccinia.

In a similar manner, the poison of a venomous insect obtains access to the general circulation from the part stung or bitten; similarly, also, the poison in snake bites, or the bites of rabid animals, or again, those putrid animal poisons often received by butchers, fishmongers, cooks, and others, whose occupations expose them to the risks of punctured wounds inflicted by soiled knives, hooks, skewers, &c., &c.

Both of these great systems of vessels are concerned in the reception and distribution, throughout the body, of those virulent specific poisons which cause the infective fevers—that great group of diseases in which we are specially interested this evening.

Infective diseases are those which are readily conveyed from one person to another, or from a lower animal to man, by the transference of exceedingly subtle specific poisons. Such diseases

do not originate spontaneously—they are always the result of the introduction into the body of poison derived from a pre-existing source. Each infective disease has its own proper virus, that produces that disease and no other; and if we could annihilate this virus altogether, that disease which it causes would be stamped out. That this is possible, though difficult, is proven by the disappearance of the plague of the 17th century, since various sanitary reforms were carried out. On the other hand, new diseases spring up now and then—for example, whooping-cough, which first appeared in France in the year 1510.

The poison or virus of an infective disease is a minute plant, variously called "a germ," "a microbe," "a micro-organism," or "a bacterium." These germs are capable of multiplying with astounding rapidity in a suitable soil, and they multiply in two ways. Some are spherical and so small that 50,000 of them, placed in Indian file, make a tiny rank one inch long. Yet such a little regiment of our foes is capable of harassing a multitude of people. Others are rod-like and so slender that 100,000, laid side by side, measure only one inch. A third group are twisted. These are respectively called the coccus, the bacillus, and the spirillus; or the ball, the rod, and the cork-screw bacteria.

In their growth I have said two modes are

followed, division of each particle into two equal segments, a process termed *fission;* or in the second place, by the formation of little seeds called *spores*, that lie in the interior of the bacilli, like peas in a pod. Our great difficulty in disinfection lies in destroying spores. These little seeds may lie dormant for years; may suffer themselves to be dried; to be frozen; may even be boiled and still remain prepared to germinate when the three conditions necessary for their growth—warmth, moisture, and a suitable soil—are forthcoming. Contrasted with spores the destruction of the fully grown microbes is easily accomplished by heating them to 77°C.

The diffusion of the germs through the air, food, drink and clothing in populous districts, brings them to bear upon a great many people, some of whom succeed in passing them through their bodies without suffering harm; while others fail to withstand them, and pass through the stages of a severe feverish disorder. Certain seasons and certain states of the atmosphere favour the development of these fevers at certain times in a special degree, and to such alarming visitations the term *epidemics* is applied.

The question now arises—How does the virus act when it obtains access to the system?

Its action is of the nature of a fermentation. Just as the yeast plant in a solution of sugar sets

up a fermentation, resulting in the conversion of the sugar into alcohol and carbonic acid with a development of heat, so in like manner, do the disease germs, which belong to the same order of plants as the yeast fungus, set up in the blood and tissues of the body a fermentation with the development of heat or fever; hence arises the term "Zymotic Diseases," derived from the Greek "Zymoö," to ferment. Further, as the yeast fermentation comes to an end after a little in the solution of sugar, no more alcohol or carbonic acid being formed, so in like manner do the morbid fermentations in the body come to an end after some days. Then the crisis of the disease is reached, and the fever, which almost invariably accompanies it, ceases also. That different germs should set up different kinds of fermentation is what we should expect; and accordingly we find different diseases, with different symptoms, with different durations, and with the different endings of the various infective fevers—for example, the fortnight course of typhus, the four weeks of typhoid, the few days of chicken pox or influenza, and so on.

Turning now to the very interesting problem of immunity. The immunity enjoyed by many persons from the infective fevers has received much attention of late. Why can some resist while others yield to the infection?

A provisional explanation has recently come from Professor Metschnikoff of Paris. You are all doubtless aware that the body is made up of little particles called *cells*—some round, some oval, some elongated, some twisted, and some branched. By an interweaving of these cells in various ways, skin, muscles, nerves, vessels, organs, and bones are made up. By the division of labour each set of cells has some duty to perform. Professor Metschnikoff has shown, that certain cells throughout the body have for their business to seize upon any injurious substance, introduced from without, and weaken or destroy it, and finally to cast it out. Such cells are to be regarded as the soldiers and scavengers of the body; and as they perform their duties by eating the injurious substance, they have been called "Phagocytes."

Now, immunity from infective disorders may be explained in this way. Those persons whose vitality is high, whose phagocytes are in prime fighting order, ever on the watch for stray microbes of disease, whether inhaled into the lungs, or swallowed with the food and drink into the stomach and intestines, are saved from the entry of these microbes into the blood and tissues by the vigilance and activity of their phagocytes or fighting cells. Should a few microbes by any chance escape these sentries and enter the blood,

they will have become so crippled and weakened that they are not capable of doing material damage. On the other hand, those persons whose phagocytes are few, ill-nourished, and weak, are unable to vanquish the microbes in the struggle. The microbes carry the body by storm ; revel and thrive in the blood and tissues ; set up their fever-producing fermentations, and possibly, in the long run, kill the person by the disorganization they produce. The battle-ground in these cases is the entire body ; but, in a special degree, the interest centres in the conflict going on in the cells of the lungs and air passages, and in the stomach and bowels, since in these situations the first assault is made by the microbes, which have arrived in myriads through the air, food, and drink we have used.

We must not forget to give *some* credit to our gastric juice in protecting us against certain microbes. It is probably owing to its antiseptic powers, that we can eat game in a high state, mouldy cheese, and other viands containing the germs of putrefaction. That the gastric juice is unable to cope with *all* varieties of microbes, is abundantly evident from its failure to protect us from the germs of the infective fevers.

The incidence of infective diseases is considerably influenced by two conditions—heredity and age. Very few of these affections are *directly*

transmitted from parent to offspring; that is to say, few infants at birth show definite signs of inherited disease. What is commonly transmitted is a *tendency* or proclivity to a particular complaint, or, to speak biologically, an incapacity to resist the inroads of the germs of that particular malady. This proclivity leaves such children an easy prey to the germs in question; but the actual beginning of the disease is to be traced to germs received from without after birth. In this way we have to explain the liability of certain families to consumption, diphtheria, and other zymotic diseases. We may infer from this view of the matter, that such persons may succeed in avoiding the diseases to which they are hereditarily prone, by spending their lives in districts where the specific germs do not abound.

Regarding the influence of age, it may be broadly stated, that the older we grow the liability to infective processes diminishes. Certain diseases like whooping cough, chicken pox, and measles, are nearly confined to childhood. Typhus, typhoid, and smallpox, and some others, affect, for the most part, youth and middle age. Old age, while almost exempt from the eruptive fevers, yields many victims to influenza. We may sum up upon the point of age, that no sharp age-limits can be assigned to any of the infectious diseases.

Although the specific treatment of any one

disease is beyond the scope of this lecture, I think it will be well to explain at some length, the method of treating infective diseases by the injection of preparations of the very poison it is actually designed to combat; I mean the use of "attenuated poisons" as a treatment.

I shall first explain, in some detail, what is meant by attenuation of the poison or virus of a disease, since this is the principle underlying the Pasteur treatment for hydrophobia, and the Koch treatment for tuberculosis, etc.

It proceeds upon the assumption, that the specific poison of a disease which has become weak through age, exposure, or drying, may be introduced into a healthy body without causing the severer symptoms of that particular disease. Only a light and transient effect follows its introduction into a healthy person. If now, frequent introductions of small quantities of weakened poison, largely diluted or attenuated with some simple substance like bouillon, be carried out for some time upon a healthy person, the system becomes so gradually saturated with the poison, that the body becomes, as it were, accustomed to it, and a large quantity of it may later on be introduced with impunity—no harm resulting,—the soil being, so to speak, incapable of accommodating it, having become exhausted or saturated by the frequent use of the attenuated doses beforehand.

Take hydrophobia as an illustration. After the bite of a rabid animal, the rabic poison resident in the saliva of the animal, and introduced at the time of the bite, lies dormant for days, or even months. It is, as we usually term it, "incubating." Pasteur found, that by the injection beneath the skin of a very weak or attenuated dose of rabic poison, once or twice daily —each day the dose slightly increased in strength —he was able, after a fortnight or three weeks, so to accustom the patient's system to the rabic poison, that, when the strong, virulent poison introduced at the bite had ceased to incubate, and set about starting the hydrophobia symptoms, it discovered that it was too late—the system having been occupied or saturated some days previously by Pasteur's attenuated injections. The virus from the bite therefore, *failing* to obtain a foothold—*failing* to find room in that individual—*failed* altogether to cause Hydrophobia.

The unsuccesses attending Pasteur's treatment were due to the patients delaying too long in subjecting themselves to it, the attenuated injections thus not obtaining a sufficiently long start of the poison at the bite to ensure success for the treatment.

Pasteur weakens or attenuates the rabic poison in this way. He takes a portion of the brain or spinal cord from the body of an animal just dead

from rabies, and places it in a jar, with caustic potash, for about 30 days. By this time the piece of brain or cord is a dried, shrivelled-up fragment, and any germs of rabies in it have been enfeebled by this drying process. A minute portion is chipped off and pounded up with some bouillon (or clear beef tea); then a few drops of this dilute mixture are injected into the body of the human being who is threatened with hydrophobia; next day another injection is given, prepared from a specimen, say 28 days old; next day from one 25 or 26 days old, and so on until a patient may receive an injection prepared from an animal quite recently dead from rabies, so fresh and strong that, had it been used for the first day's injection, it would almost certainly have caused the hydrophobia it was designed to prevent. When this point is reached, the patient is fully protected against the influence of the virus that was introduced at the bite, and which has all this time been "incubating." It wakes up—if we may personify the bite-poison—to find its occupation gone, the soil already possessed by the gradually inserted attenuated poison of Pasteur.

Turning now to Koch's treatment of tuberculosis—An extract is made from a piece of tuberculous meat taken from the carcase of an infected animal, and from this, by a complicated chemical process, a substance called tuberculin is prepared. Koch

found that when the germs of tuberculosis were injected into guinea-pigs, it was easy to produce in them tuberculosis. But when he employed guinea pigs, that had been subjected to a course of injections of tuberculin, he could not develop in these the disease tuberculosis. Reasoning upon this hostility of tuberculin to tuberculosis, he conceived the idea, that by injecting the former, in small doses, into tuberculous animals and tuberculous human beings, the disease might be arrested.

As all know, these injections were carried out, all over the world, in cases of tubercular consumption, with the result that few were benefited. Certainly the tuberculin fastened on the spots of tubercle, in such patients, in a most remarkable manner, and apparently destroyed them; besides exciting feverish and other depressing changes, that made many people timorous about using the remedy. The benefit was transient, the risk considerable for such a small gain; and the possibility of aggravating the disease where it failed to cure it, were held sufficient reasons for abandoning it.

Observe that Koch set himself a more difficult task in tuberculosis than Pasteur did in hydrophobia; and a modification of the principle of the attenuation of virus method is obvious on closer examination. Koch tried to *cure* a disease already in full swing, by his tuberculin injections. Pasteur tries to *prevent* a disease before the first symptoms

of it have appeared; freely admitting that against the fully developed hydrophobia his method is valueless.

The tenacity of life of the microbes of disease, or their spores, has been frequently brought forward by the advocates of cremation, as an argument in favor of cremating the bodies of the dead. Being of a vegetable nature, these spores live and thrive in the earth, and, inasmuch as the body of even one patient dying from an infective disease contains millions of germs, each cemetery must contain an inconceivable number. Such cemeteries, and also cathedrals and churches used in the burial of the dead, may become so many nurseries in which seeds of death are being multiplied for the destruction of the living. Mr. Wheelhouse, of Leeds, records the case of scarlatinal germs germinating after 30 years. "In a Yorkshire village part of a closed graveyard was taken into the adjoining rectory garden. The earth was dug up—scarlatina broke out in the rectory and spread to the village. It proved to be of the same virulent character that destroyed the villagers thirty years before, who were buried in that precise spot."

Take some other illustrations quoted by Sir Spencer Wells—From the earth surrounding the body of a man, who died of yellow fever a year before, the germs of the disease were easily

obtained. Animals, placed in a confined space along with some of the mould from this grave, died in five days, their blood and tissues being found crammed with the germs of yellow fever.

The malarial fever of the Campagna at Rome is believed to depend upon a microbe, which lives and thrives in the soil.

Pasteur has shown that the infective disease called "charbon" is caused by specific germs, that propagate themselves in the earth as well as in a living body. A diseased cow was buried in a field among the Jura Alps—two years later the surface mould was examined, and although the carcase had been buried seven feet below the surface, and the earth had not been disturbed in the interval, Pasteur was able to obtain plenty of germs, which, when introduced into other animals, produced "charbon" in them. The bodies of earth-worms in such situations are found full of germs, which they have eaten with the mould these creatures take in in such quantity.

Now, when we remember that Darwin, long ago, showed that earth-worms in old pasture land pass the *whole surface earth* through their bodies in the course of years, burrowing deeply down in the dry seasons, and coming to the surface in the damp, we can see how disease germs may be freely scattered in the surface mould, in places where bodies have been interred that contained

infective germs. Who would have thought that such humble forms of life as the earth worms, would perform such an office, becoming the unconscious agents of unearthing, if one may use this expression, deadly germs that were believed to have been safely buried long previously?

Imagine the effect of animals eating the herbage; of fowls eating the worms in such infected areae. Imagine the effect of dews and still heavier rains upon such earth, washing the germs into streams and wells, whence human beings and animals draw their supply for drink, and you will have some idea of one channel of infection, viz., the earth and earth worms.

Such considerations, in the estimation of Sir Spencer Wells, Sir Henry Thompson, and others, strongly favor cremation of the dead, instead of the risky mode of burial in vogue in these countries.

*Air as a Channel.*—Many microbes of disease are so heavy that a fluid medium like water is required for their conveyance, but a greater number are so light that they are easily borne by the air. From this they may enter the system with each breath. The particles of scarlatina, typhus, influenza, smallpox, measles, whooping-cough, etc., doubtless exist, in the form of the finest dust, in the air where these affections are prevalent.

Professor Tyndall pointed out that the expectoration of consumptives, if allowed to fall on the floor, or emitted upon handkerchiefs or bits of paper, dries into dust. This dust, abounding in tubercle-bacilli, mixes with the air in the room when it is swept or dusted, or when clothes are shaken, and becomes a source of danger to those about the patient who breathe such tainted air. Such expectoration should be received into moist receptacles, and subsequently destroyed by fire.

The practice of shaking carpets, curtains, and bed-clothing used in sick rooms is most reprehensible. Those fabrics that *can be dispensed with* should be taken from such a sick room at the beginning of the disease. Those that must be employed should, after use, be received into basins containing antiseptic solutions; and, if not capable of being boiled they should be super-heated in ovens or other disinfecting chambers. Dust should be removed by damp cloths that can later on be burnt; and walls and wood-work re-whitewashed and re-painted, after the room as a whole has been filled with sulphur or chlorine fumes.

I must not omit to warn you against the popular fallacy, that the mere exposure in sick rooms of odorous antiseptics, in the form of powders or solutions, can effectually disinfect the apartments. Such things as carbolic acid, creosote, permanganate of potash, various balsams, and a host of

patent preparations, the virtues of which are extolled in showy advertisements, are in general use. Some of these fill the room with their characteristic odours, giving rise to a feeling of false security. We ought to regard these as *deodorants* rather than *disinfectants*, and by no means neglect to thoroughly disinfect by burning, boiling, and super-heating. Bear in mind, that many of these materials, in solution, are very valuable for saturating the soiled linen, for receiving the expectoration, urine, and the dejecta from the bowels, or for anointing the skin of a patient; but in this mode of application they come into thorough contact with the infective particles. What I wish to emphasize is this, that the vapour of them is incapable of disinfecting properly.

At one of the earliest Intermediate Examinations in Chemistry, in answer to the question, "What is the composition of air?" a pupil replied, "Oxygen, nitrogen, and birds." In connection with infective processes we may modify this extraordinary answer and say—oxygen, nitrogen, and flies!

Darwin discovered that in the propagation of those beautiful flowers, the orchids, bees were the unconscious agents of fertilizing the plants. Visiting one plant in quest of honey, the bee carries to the next some of the pollen grains adhering to its hairy limbs, and thus the process of

fertilization is carried on. In a similar manner the house-flies in sick rooms and hospital wards, alighting unnoticed on foul wounds or foul dressings used in septic cases, may readily carry the germs of some fatal blood-poisoning diseases to the otherwise healthy wounds of neighbouring patients. In over-crowded military hospitals in time of war, where, through pressure of work, the flies are perhaps overlooked, the spread of erysipelas, gangrene, and septicæmia may, now and then, be traced to the meddlesome interference of the flies.

*Water.*—Water is oftener the vehicle of infection than solid food. When we recollect that a whole city may use water from a single source, but draw its solid food supplies from a multitude of sources, we can realize how far-reaching and disastrous the effects of tainted water must be. Moreover, the use, by a town, of river water which may have been polluted by refuse of towns situated higher up the stream, is a fertile source of disease. Two diseases, in a special degree, spread through infected water—typhoid fever and cholera.

Take an illustration:—

In Millbank Prison, London, up till 1854 the water of the Thames was used, and the prison had a very bad reputation for the number of typhoid cases within its walls. In 1854 a well was sunk in Trafalgar Square, from which the supplies for

Millbank were next taken. Since this change no case of typhoid has occurred in the prison, that was not brought into it by some newly-arrived convict.

Water used to dilute milk, or even to wash milk cans, has often been the means of disseminating typhoid, when taken from a contaminated source.

In India the practice of throwing corpses into the Ganges when cholera is rife, or even the reception by the Ganges of the refuse of choleraic towns, is a fearful agent in spreading this affection in the towns and villages through which the sacred river flows. It is a curious fact, that those cities upon its banks, that have lately supplied themselves with water from a distance, thus doing away with the necessity of using the river water, have almost banished the disease; while those whose unenlightened authorities have failed to carry out this sanitary reform, are seldom free of this scourge.

*Milk.*—That milk is an admirable medium for microbes to grow in is well-known. It contains all the materials necessary for their cultivation, and no better proof than its liability to sour or curdle can be adduced of this adaptability, for, the souring or curdling is caused by microbes, which set up a fermentative change in the milk. The usual plan of exposing milk in large shallow pans for creaming, affords a large collecting surface for micro-

organisms to fall upon. Then, considering the large number of persons supplied with milk, even from a single dairy—thousands of consumers it may be—we cannot wonder that milk, as a vehicle of infection, is second only to water in importance. Scarlatina and diphtheria are often conveyed in this way. At Hendon, in Buckinghamshire, in 1882, an epidemic of diphtheria occurred. What surprised the inhabitants most was, that the disease appeared in the houses of the well-to-do, situated on rising ground, and with new and perfect sanitary arrangements. Nine out of ten of the stricken families were supplied by the same dairy, which, on investigation was found to be the source of the germs, there having been a case of this disease at the farm at the outset of the epidemic.

The dairy farms supplying London with over 90,000 gallons of milk every day, are bound under a heavy penalty (I think £100) to cease sending it to London, the moment a suspicious disease makes its appearance among the employes at the farm.

But milk may be infected from the very first. The germs of tuberculosis have been often found in the milk of tuberculous cattle; even the milk of a tuberculous woman may contain such germs. The use of tuberculous milk is more dangerous than the eating of tuberculous beef, though both

are risky, for, cooking the beef (a practice universal in this country) goes far to render it innocuous. On the other hand, milk is often used uncooked, hence its greater liability to spread this disease.

Here is an interesting fact in this connection:—Four out of ten of the children, dying in our children's hospitals, die of tuberculosis in some of its forms. In early infancy while children are nourished by mother's milk, tuberculosis is rare, but after weaning and through early childhood the number of cases is appalling. Such a susceptibility, just at the age when uncooked cow's milk enters largely into the dietary of children, is presumptive evidence of the power of tuberculous milk to infect.

Is it any wonder that sanitarians clamour for a rigorous examination of milk by scientific experts, and the institution of heavy penalties for selling contaminated specimens?

*Solid Food.*—The evidence in favour of infection by solid food is increasing. Long ago, Professor Chaveau fed three heifers with material from the body of a tuberculous cow, and produced tuberculosis in the heifers. From the identity of the disease in animals with that in man, there is no reason to doubt that the disease may arise in man from eating tuberculous meat, if the cooking to which it has been subjected have not destroyed the bacilli.

The pathology of leprosy cannot yet be considered as definitely settled, but many experienced investigators incline to the opinion, that it spreads, not by personal contact or contagion, but by the use of uncooked or insufficiently cooked fish, the flesh of which is often infested by a microbe—the *bacillus leprae.* If this view prove to be correct, the isolation of lepers in leper settlements is unnecessary. Prevention is rather to be sought in the thorough destruction of the microbe by thorough cooking of the fish. Leprosy was once common in Ireland, when uncooked salmon were largely consumed by the peasantry. It occurs in Norway, India, and Africa, and other countries where fish are plentiful. When the disease appears in inland districts, it has been observed that the districts involved border upon lakes or rivers, whence fish are drawn, and enter largely into the dietary of the inhabitants.

The difficulty in proving infection by meat in any individual case is very great, man being so omnivorous a feeder.

A reference only need be permitted to those diseases caused by *animal* parasites or worms, since these do not properly belong to the zymotic or infective group. Helminthiasis, in some of its forms, depends upon the consumption of beef, pork, and shellfish, containing the embryoes of tapeworms. Trichinosis is an affection produced by

minute spiral worms, that have obtained access to the muscles of the patient, through the use of infected flesh meat. About the dependence of these complaints upon infected food there is no doubt.

*Clothing.*—That clothing may carry the seeds of disease has been often proven; and what is said of clothing may also be said of the covering of domestic pets, of books, of stationery, and a host of articles in daily use.

In a family in which scarlatina had broken out, the healthy children were promptly sent off to the country for three months. After a disinfection of the house they were brought back again. A new nurse took a muffler that had been used by the patient, and which had been hurriedly put into a drawer before disinfection, and applied it to one of the newly-arrived children. In two days the child sickened and died.

Take another illustration: "A Persian cat in Chicago, that visited at several houses, was caressed by a little scarlatina patient in one of them. The disease subsequently broke out in some of the other residences that the cat now and then visited; the virus doubtless carried by the silky fur of the animal."

In the light of these facts we must regard as immoral, not to say criminal, such practices as convalescents from infective diseases travelling in public conveyances; the sending of infected linen

to public laundries, or mats, carpets, and clothing to public cleaning establishments.

I purposely omit all reference to those channels of infection opened up through defects in the construction of our dwellings, as this branch of the subject falls within the scope of another lecture in this series. I therefore pass on to a brief review of the means at our disposal for limiting zymotic disease.

*Isolation and Disinfection.*—The methods commonly adopted to prevent the spread of a disease of an infectious nature, are isolation and disinfection. Incidentally I have alluded to the latter.

By isolation we mean the separation of the sick from the healthy, and also the isolation of an infected water supply or milk supply, until it is no longer prejudicial. Among the well-to-do classes this may often be carried out, but in the homes of the poor it is seldom possible to provide separate rooms and attendants, so as to ensure success.

"It is a pity that civilized communities are so slow to see the advantage of small hospitals for infectious cases, so as to meet this want. When the establishment of such is urged upon the authorities of a town, the reply is, that it is an unnecessary expense; that people would not go to it; and that such an hospital is itself a source of danger. The real truth is, that such an hospital

costs very little; that it is the cheapest insurance against epidemics a town can have; if it be properly kept and made comfortable, people will use it; and if intelligent care be exercised in conducting it, there need be no danger to those in the vicinity. Usually a community does not waken up to recognise the necessity for such measures, or to voluntarily inflict upon itself the necessary taxation for their support, until neglect of them is forced upon its attention by a dreadful epidemic." The result is, the burden becomes far heavier than if undertaken at a proper season, and an avoidable sacrifice of human life has to be added to the pecuniary outlay.

It must be obvious, that unless such an hospital is provided, the compulsory notification of infectious diseases is useless and vexatious. This notification, upon the part of the relatives or medical attendants of infected patients, in the present state of public opinion, presents some difficulties which I trust are not insurmountable. As information upon the nature of these morbid processes increases, we approach nearer to a realization of this scheme. To be of service all persons must loyally support such a practice, both medical and lay; for its universal adoption is necessary, if it is to be of the slightest use in securing the public safety.

"Meantime, we must give to the health officers of our cities large powers to enable them to contend

with ignorance, custom, and self-interest. Their action must be prompt and unrestricted, if it is to be efficacious."

Surely, ladies and gentlemen, it is our duty to inculcate among all classes, but especially among the poor, the principles of cleanliness in its widest sense, and of disinfection where this is necessary; in the expectation, that the ravages of zymotic diseases may be limited.

Already typhoid fever and tuberculosis, in proportion to the population in Ireland, show signs of decreasing before a more exacting hygiene; and, it is not too sanguine to expect, as in the case of the Plague already alluded to, the total extinction of some maladies of the zymotic group. In directing efforts towards the attainment of this object, we may draw encouragement from the comparative rarity of typhus fever and relapsing fever; diseases, once very common in Ireland, which are much favoured in their development by want, over-crowding, and defective ventilation. Formerly, nearly every physician and clergyman contracted typhus in the course of his professional labours. Nowadays, few of the younger physicians have ever seen a case of typhus.

There is, no doubt, vast room for sanitary improvement in our environment, and, as our knowledge of our microbic enemies and their tactics increases, we shall be occasionally enabled to

*prevent* a disease, that if allowed to become epidemic would not be easy to cope with.

We shall consent to pay more attention to Nature's laws, which are not to be broken with impunity. That this attention need be neither a panic-stricken appeal to the Legislature, during a devastating epidemic, to do for us what each person ought to do for himself; nor a narrow and selfish attempt to provide for our own immunity, no matter who suffers, I need hardly wait to insist.

Let us have a steady advance, all along the line, in sanitation; an advance guided by an intelligent idea of the forces we have to contend with, and based upon a painstaking attention to those details in the defence, that may be so constant in its operation as to habituate us to precautionary measures. Then the adoption of such measures by us becomes almost a second nature or instinct. Let each individual citizen do his or her duty in the way of sanitary reform, and the result will be, the very great amelioration of the sufferings of humanity.

# THE AIR WE BREATHE.

By E. A. LETTS, Ph.D., F.R.S.E., F.C.S.,
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AT the two great crises of our life, air is the all-potent factor. Our first breath ushers us into the world, and with our last we quit it. We can, for a time, exist without food, without drink, without a dwelling, and without clothes, but deprive us for a few minutes of air and we die. And yet as Angus Smith says "when we are children, air is to us nothing. A vessel of air is a vessel with nothing in it. . . . . . Instead of thinking it nothing we are now inclined to go nearer to the other extreme. We have learnt that its condition as to warmth, speed, and weight, is so important that we appoint institutions over all the world for the purpose of measuring the

frequent variations; while the moisture has a most important influence on our lives."

We live *in* air, and to a certain extent *on* air, for it is continually flowing into our blood. No wonder, then, that we are influenced by climate, which means the condition of the air. The whole question of air is of vital hygienic importance, and I have been entrusted this evening with the task of telling you how far our knowledge of the subject extends. With your permission I shall divide it into the following heads :—

1. The composition (or nature) of air.
2. Its impurities.
3. Vitiation of air by human beings, and removal of foul air by ventilation.

To the best of my belief the ancient Greek philosophers were the first to speculate in anything like a rational way on the nature of air, and the opinion at which they arrived was, that it was an element or one of the first principles of matter; indeed, Anaximenes went so far as to maintain that it was the *arche* or first principle from which all other things are produced.

The belief that air is an element was retained until the seventeenth century, when Hook, Rey, and Mayhow came to the conclusion that it contains a certain principle which supports combustion, *i.e.*, allows combustible things to burn in it—a principle which Mayhow called by several

names, viz. :—"Nitre Air, Fire Air, and Nitro-Ærial Spirit"; and that ordinary saltpetre contains the same substance in a more condensed form. None of these observers appear to have isolated this principle. It was reserved for Priestley to do so.

On the 1st of August, 1774, Priestley isolated oxygen for the first time, and proved it to be a constituent of air. He obtained the gas by heating red oxide of mercury, which is produced by heating mercury to a lower temperature in contact with air.

[The experiment of obtaining oxygen by heating oxide of mercury was shown, and also some of the properties of the gas, especially the brilliancy with which substances burn in it.]

Two years earlier *i.e.*, in 1772, Dr. Rutherford, Professor of Chemistry in Edinburgh, had examined air as follows :—

He first allowed animals to breathe in it—then he treated the air which remained with caustic potash. What was left, though still like air, was found to have perfectly different properties, for it now extinguished a candle, and animals died when immersed in it. In the same year Priestley found that if charcoal is burnt in a closed volume of air as long as possible, and the air thus treated is allowed to stand over quicklime, it diminishes by one-fifth, and with the residue he made the same

observation as Rutherford, viz., that it would neither support life nor combustion.

Priestley, however, did not apparently consider that his experiment showed that air contained two distinct gases. We owe the first distinct statement of this fact to the great Swedish chemist Scheele, who ascertained it from his own exhaustive and admirable experiments.

An experiment of Lavoisver's also demonstrated conclusively that air contains two distinct gases. By heating mercury in a measured volume of air he found that about one-fifth is absorbed by the metal forming the compound (red oxide of mercury or "red precipitate") from which Priestley had obtained oxygen, while the remaining four-fifths had all the properties of the "mephitic air" of Rutherford. Lavoisver correctly maintained that this gas is an undecomposable substance or element as we now say, and he called it *azote.* This constituent, Chaptal suggested should be called nitrogen (*i.e.* saltpetre producer)—the name which we now know it by.

The net result of all these different researches was then to prove that air is composed of two different gases, viz : oxygen and nitrogen. I have told you how Priestley isolated oxygen from air, and also, indeed, nitrogen, though he did not realise the fact.

A simpler and more rapid method than his may

be employed for separating nitrogen from air, and this I now proceed to show you; and the experiment is particularly instructive, as not only shall we isolate the nitrogen, but also demonstrate roughly the quantitative composition of the air.

[The experiment shown consisted in burning phosphorus in a vessel containing five volumes of air. After the combustion was over and the residual gas had cooled, it occupied only four volumes. It consisted of nitrogen, the phosphorus having combined with the oxygen.]

The properties of nitrogen are of a very negative kind. The only one I can show you is that a candle will not burn in it, or as the chemist says, it is a non-supporter of combustion.

Now, comes the question—In what condition are the oxygen and nitrogen in the air? Is air a chemical compound, or merely a mechanical mixture? We shall see presently that the distinction between the two is very important and always well marked. In an elaborate series of experiments, Cavendish showed that the composition of the air *i.e.*, the relative proportions of its two constituents does not vary from time to time, or in different localities—so far at least as he could ascertain—and this induced many chemists, notably, Prout, Döbereiner, and Thomson, to conclude that air is a compound; for constancy, in chemical composition is one of the characteristics of chemi-

cal compounds. But against this view Dalton protested, and without carrying you further into the controversy, I will tell you at once that he was correct. Air is not a compound at all, but simply a mechanical mixture of oxygen and nitrogen.

The distinction between mixtures and compounds is a question of considerable importance in chemistry, and speaking generally, the differences between the two are exceedingly sharply defined.

1. In the first place, if you simply mix two substances, no heat is generated; whereas, almost always when a compound is formed, heat is given out.

2. Secondly, the properties of a compound are never the same as those of its constituents. Now, the properties of air are not different, or not very different from the properties of the two gases contained in it. They are just the properties which one would anticipate from a mere mixture of the two—a kind of mean in fact between those of the very active substance oxygen and the inert gas nitrogen—or, to put it another way, the properties of air are the properties of oxygen, the nitrogen merely diluting it. Take for instance the case of the candle burning in oxygen and burning in air. In the one we have intense combustion, in the other a much slower combustion.

3. In the third place, the composition of a compound is invariable and cannot be altered; thus, water always contains exactly—

| | |
|---|---|
| Hydrogen, | 11·136 |
| Oxygen, | 88·864 |
| | 100·00 |

and so long as we are dealing with pure water we cannot change these proportions.

But the composition of air is *not* invariable, although Cavendish thought he had proved it to be so.

Regnault found in 100 samples of air—

| | |
|---|---|
| Oxygen, max. | 20·999 |
| „ min. | 20·913 |
| Variation, ... | ·086 per cent. |

Hempel found—

| | |
|---|---|
| Oxygen, max. | 20·971 |
| „ min. | 20·877 |
| Variation, ... | ·094 |

and we can easily change the composition of air without materially altering its properties, by certain mechanical processes which would not change the composition of a compound.

So putting all these arguments together, we clearly prove that air is a mechanical mixture and not a compound.

The next point I come to is—how the proportions of nitrogen and oxygen present in air are ascertained. I can actually show you the method of analysis, and it is instructive. As pure air only contains the two things, oxygen and nitrogen, it is sufficient to determine the amount of one of these in the air to get at the composition of the latter—for the amount of the other will obviously be the difference between the total amount of pure air taken and the quantity of the one constituent found. You have already seen a rough method of analysis, for you will remember the experiment I showed you at the commencement of the lecture, in which we removed the oxygen from air by burning phosphorus in it, and found that the volume diminished by one-fifth; therefore, air is composed, roughly speaking, of one-fifth oxygen and four-fifths nitrogen. But this method is not sufficiently delicate for scientific purposes, and fortunately we have several others.

[Two experiments were shown to illustrate the methods employed by chemists in the volumetric analysis of air. In the first of these an accurately measured volume of air was treated with a mixture of pyro-gallic acid and caustic potash solution, which absorbs the oxygen and leaves the nitrogen. In the other, a measured volume of air was mixed with a measured volume of hydrogen and the

mixture exploded by an electric spark. As two volumes of hydrogen and one volume of oxygen form water, one third of the total contraction which occurs after the explosion corresponds with the volume of oxygen contained in the air.]

We can also determine the *weight* of oxygen very simply, viz.: by passing a known weight of air over red hot copper, which absorbs the oxygen and combines with it, while the nitrogen passes on unchanged. If we weigh the copper after the experiment the gain in weight corresponds with the oxygen, and we have only to subtract the amount thus found from that of the air taken to get at the weight of the nitrogen.

The following summary of the results obtained by the best workers in this field may be of service:—

COMPOSITION OF AIR BY WEIGHT.

| | | | Percentage of Oxygen. |
|---|---|---|---|
| Dumas and Boussingault | (Paris) | 1841 | 23·005 |
| Löwy | (Copenhagen) | 1841 | 22·998 |
| Stas | (Brussels) | 1842 | 23·100 |
| Marignac | (Geneva) | 1842 | 22·990 |

And we may therefore say that air contains 23 per cent., by weight, of oxygen, and 77 per cent. of nitrogen. An immense number of determinations of the composition of the air by volume have been made—by Regnault, Angus Smith,

Frankland, Hempel, and others. The results show that locality has a distinct influence. Thus air at the sea-side and from Scotch moors and mountains may contain as much as 21 (20·999) volumes per cent. oxygen, while in towns it may sink to 20·82, and in theatres and crowded places and in mines it may fall to 20·26.

Roughly speaking, air contains 21 volumes oxygen, and 79 volumes nitrogen per cent.

We now come to the subject of the impurities of air. Fresh air is absolutely necessary for health, and just as we never meet with perfectly pure water in nature—so it is with air. Perfectly pure air being an unknown thing in nature. You will readily understand how this is the case, for the air being in a constant state of agitation, and blown perpetually over sea and land carries away with it water vapour from the sea and from the land, gaseous emanations, and even solid particles.

One of the most important impurities in air is carbonic acid, or to speak more correctly, carbonic anhydride. The sources of this gas are very numerous in nature, and some of them I can show you experimentally.

[Experiments were shown to prove the production of carbonic acid by the combustion of candles, gas, etc., by putrefaction, fermentation, and respiration : the presence of the gas being demon-

strated in each case by the turbidity it causes with lime water.]

Now, carbonic acid when inhaled in large quantity, kills animals as surely, and nearly as swiftly as a cannon shot. Breathed in small quantities it decidedly acts as a poison.

Consider now the extent to which the different processes are going on, which I have pointed out, as sources of the gas—putrefaction and decay, fermentation, respiration of animals, and combustion—you will possibly feel some alarm at the prospects for human beings; for, very naturally, you will imagine that the quantity of carbonic acid must be increasing, and will bye-and-bye destroy all animal life on the globe.

Fortunately, however, there is a very beautiful device of nature's for checking the increase of carbonic acid in air. Plants come to our aid, for it is one of their functions, as Priestley ascertained by actual experiment to renovate air charged with carbonic acid. Under the influence of light, the green colouring matter (or chlorophyll), which they contain, decomposes the carbonic acid of the air; and, although the actual chemical processes occuring are probably complicated, the final result is that the carbonic acid is completely decomposed, the carbon which it contains being absorbed as food by the plant, whilst the oxygen, its other constituent, is discharged into the air. Thus

plants undo the work which animals have performed, and the two exercise a reciprocal action on the air. The animal breathes in oxygen and exhales carbonic acid, which in sufficient quantity would poison it. The plant absorbs this poisonous matter, lives upon it indeed, and exhales pure oxygen, so that nature by this beautiful device constantly keeps the quantity of carbonic acid below an injurious amount—just sufficient for vegetables to feed upon, and just insufficient to harm animals. Indeed, the limit seems to be very narrow, and in foggy weather the quantity of carbonic acid in the air is probably on the verge of being injurious to human life, at all events.

For various reasons the amount of carbonic acid in the air affords the readiest criterion of its healthiness, and therefore, it is essential that the chemist should have an accurate, and if possible, simple means of measuring its amount.

Such a method is Pettenkofer's, which, in a slightly modified form, is now generally employed.

*Pettenkofer's method.* Principle—A definite amount of acid is neutralized by a definite amount of alkali. Neutralization is shown by the change in colour of certain colouring matters. A solution of alkali is made, one measure of which will exactly neutralize one measure of carbonic acid. A known volume of air is shaken with a definite quantity of the alkaline solution (Lime or Baryta

water), when the carbonic acid is absorbed, and the excess of alkali subsequently determined by running in solution of an acid of known strength.

Much work has been done regarding the actual quantity of carbonic acid present in air. The following may be considered as a summary of the results obtained:—

Pure Air (country and sea-side) 3 vols. carbonic acid in 10,000 air.

Air in well-ventilated houses, below 7 vols. carbonic acid in 10,000 air.

Air in fogs, 7—10 vols. carbonic acid in 10,000 air.

Air in theatres, buildings, and close places, 20 and more vols. carbonic acid in 10,000 air.

According to Angus Smith, we instinctively avoid an atmosphere containing 10 vols. carbonic acid.

*Water in Air.*—Perhaps I ought to have considered this before the carbonic acid in the air, as the actual amount is greater.

Let me put it to you in this way. Supposing we have a cubic mile of air, and we allow it to take up as much water as possible, say, by passing over the Atlantic, and suppose its temperature is thirty-five degrees centigrade when it reaches us, and it is then saturated with water and that we happen to have a frost with the temperature at

0., and it is cooled down to that temperature, what would happen? The cubic mile of air would deposit 140,000 tons of rain, sleet, or snow, as the case might be.

Atmospheric moisture is unfortunately a very prominent impurity of the air in the British Isles. We have far too much of it for our comfort; but as we shall see presently it has compensating advantages. For the moment, let me direct your attention to its measurement.

This is done either by means of wet and dry bulb thermometers, or by Daniel's dew point hygrometer. The wet bulb thermometer, as its name implies, is a thermometer whose bulb is kept constantly moistened by water, which rises by capillary attraction up a piece of lamp wick connected with muslin, which surrounds the bulb. The dryer the air so much the faster does the water evaporate from the muslin, and, as a consequence, the temperature falls (as evaporation produces cold); thus, the difference between the readings of the dry and wet bulb thermometers is proportional in magnitude to the moisture of the air, and the actual amount can be ascertained from tables constructed for the purpose.

Daniel's dew point hygrometer is a very beautiful little instrument, which gives directly the "dew point," or temperature at which the air is *saturated* with water. It consists of two bulbs

containing ether, which communicate with each other by a tube bent twice at right angles. One of these bulbs is blackened, and has a thermometer within it; the other is enveloped in muslin. To make an observation: Ether is poured over the muslin, which evaporates rapidly, produces cold, and causes the ether within the blackened bulb to distil over, and in its turn to lower the temperature of the blackened bulb. The moment when the dew point is reached, is known by a ring of dew which forms on the blackened bulb. The temperature of the latter is now read, and the actual quantity of moisture in the air ascertained from a specially constructed table.

We now come to the other impurities of air, which it is true occur in minor amount, but are notwithstanding of much importance, as their quantity has a considerable bearing upon the healthiness of the atmosphere, and not only so, for they are also of remarkable interest to the agriculturist.

I have before pointed out that air is constantly taking up impurities from the land and sea; from the land gaseous emanations and solid matters in the state of dust; from the sea chiefly water vapour, but also spray, and, as a consequence, salt. Now when such air is cooled down a great deal of the water is precipitated as rain, and the rain carries down a

very considerable proportion of the atmospheric impurities.

Thus, rain is the great device of nature for purifying air, and it follows that a study of the substances found in rain should give us information regarding the impurities of air.

This subject has been very carefully investigated by a number of eminent observers—Pierre, Barral, Boussingault, and others on the continent, and by the late Dr. Angus Smith, in the British Isles.

I may as well, at once, give you a list of the chief of these impurities, pointing out the sources from which they are derived—

Organic matter, consisting of the debris of plants and animals, and also the spores of lower forms of life.

Nitric acid.

Sulphuric acid.

Chlorine.

Ammonia.

Dust.

The actual quantities of these impurities in a given weight of rain appear small, but viewed from another standpoint, viz., on the total quantity of rain which falls, their amount is seen to be really very considerable. Barral found that every acre at Paris receives annually, by rain, nearly

| | lbs. |
|---|---|
| Nitric acid............ | 56 |
| Ammonia...... ...... | 13·4 |
| Chlorine............... | 11·4 |
| Lime .................. | 27·4 |
| Magnesia.............. | 8 |
| | 116·2 |

(contained, probably, in about 13,000,000, lbs. of rain.)

Thus, from the agriculturalists point of view, rain is a most important substance, not only moistening the land and nourishing the crops, but actually being of great manurial value.

" We can understand, by the aid of these facts, how it is possible (in some indefinite way) to produce crops without manure, by the system of fallow land." (Pierre).

Turning our attention to the other impurities of rain :—

*The organic matter* in air we may consider as its sewage, for by it we understand the debris of plants and animals and some of their products of decomposition, as well as the spores of some minute organisms, such as moulds, mildews, bacteria, etc.

Its amount we infer from that of what is called " albumenoid ammonia," that is to say, the ammonia which is produced when albumenoid sub-

stances are boiled with a mixture of permanganate of potash and caustic potash. We may consider the albumenoid ammonia as a measure of air sewage not purified.

*Nitric Acid* is due very largely to the oxidation of organic matter. Its amount is therefore not only a measure of the impure matter in air, but also of the progress made in purifying or cleansing it. It must, however, be recollected that atmospheric electricity also causes the formation of nitric acid directly from nitrogen, oxygen, and water, so that it does not invariably originate from decaying nitrogenous bodies.

*Sulphuric acid or sulphate.*—"The sulphate has been said to be so important that when coal smoke is not in question it may be held to indicate the amount of sewage of the atmosphere.

The most dangerous products of decomposition come from substances containing nitrogen and sulphur. The first we find in ammonia and nitric acid, the second in sulphate." *(Angus Smith.)*

The sulphur present in coal and in coal gas, and which is converted into sulphuric acid when they are burnt also, of course contributes very largely to the quantity of this impurity in the air of towns.

*Chlorides.*—"It has often been observed that chloride of sodium or common salt is found on windows far from the sea when a violent wind is blowing." Angus Smith was anxious to know

how far this might be considered the natural mode of supplying that substance to soils. "We know," he says, "that plants use it and that animals require it. Experiments show that it is found in greatest quantities in the air off the coast; but that there is another source of it, namely, the coal burnt in our towns. The rule is that it diminishes as we leave the coast, and increases again as we enter towns; but it does not rise so high in towns as it does during wind from the sea and near the coast. Taking London and theSouth it is the distance from the Western sea chiefly that governs the amount. There is also an increased amount when we approach alkali works and such glass works and potteries as decompose salt. The chlorides become therefore a test both of sea water and of coal burning, especially as connected with certain manufactures."

*Oxygen required to oxidize air impurities* (permanganate test). If we mix a solution of permanganate of potash (Condy's fluid) with oxidizable substances and sulphuric acid, it loses its colour and oxidizes the substances. The test imitates in the laboratory more or less, the natural purification of air by oxidation of the impurities. The more oxygen required the greater the amount of impurities.

The following table I have abstracted from Angus Smith's classical work on "Air and Rain: The Beginnings of a Chemical Climatology" and

I wish to draw your attention specially to it as it illustrates, in a very remarkable way, the dependence of air impurities on locality:—

RELATIVE AMOUNT OF RAIN-WATER IMPURITIES

(ANGUS SMITH.)

| | Albumenoid Ammonia | Nitric Acid. | Sulphuric Acid (Sulphates). | Hydrochloric Acid (Chlorides). | Parts by Weight Oxygen Required per Million Parts Rain. |
|---|---|---|---|---|---|
| Ireland, Valencia. | 1 | 1 | 1 | 100 | 2·72 |
| Scotland, Inland Country. | 1·15 | 0·83 | ·755 | 6·9 | 14·67 |
| Scotland, Sea-coast Country, West. | 3·09 | 1·01 | 1·322 | 25·2 | 1·0 |
| Scotland, average. | 3·11 | 1·15 | 2·064 | 25·9 | 18 5 |
| Scotland, East. | 3·1 | 1·29 | 2·806 | 26·5 | 36·06 |
| England, Inland. | 3·21 | 2·02 | 2·022 | 8·2 | 25·89 |
| German, specimens. | 3·59 | 7·81 | 6·007 | 2·7 | 11·22 |
| Liverpool. | 4·67 | 1·57 | 14·502 | 20·9 | 216·44 |
| Runcorn. | 5·59 | 0·75 | 8·652 | 52·9 | 60·55 |
| London, 1869. | 6 03 | 2·27 | 7·505 | 2·6 | — |
| Scotland, Towns. | 6·23 | 3·14 | 6·044 | 12 | 104·39 |
| England, Towns. | 6·29 | 2·33 | 12·553 | 17·9 | 152·39 |
| Manchester, 1869. | 6·38 | 2·39 | 15·26 | 12·1 | 113·89 |
| Glasgow. | 8·82 | 6·72 | 25·71 | 18·4 | 557·78 |

The general lesson which this table teaches us is clear enough, and scarcely requires comment. We see very plainly that the air of the Atlantic (Valencia) is singularly pure, but highly charged with salt. As it passes over the land, even in country places, it begins to be polluted, and it also loses its salt. The pollution increases in a very marked way in towns, and apparently culminates in Glasgow. As regards the final column which represents the result of the permanganate test, Angus Smith says :—"This I consider a very remarkable table. It includes most of the other results and gives a rough summary like a touch of common sense simplifying the most tangled figures."

On looking at this table, as a whole, you will, I feel certain, at once realize and understand the advantages of a "change of air"—especially to the sea-side, and see why it is that the physique of workers in close ill-ventilated buildings (so many of which unfortunately exist in all large towns) is so wretchedly low.

If we compare the sun-burned visage and broad shoulders of a sailor, with the sallow complexion and hollow chest of many of our mill and factory hands, we cannot fail to appreciate the vast importance of pure fresh air, and the melancholy fact must, I fear, strike us that in proportion as our manufactories increase, the physique of our popu-

lation, or a section of it at all events, deteriorates

You will, I think, agree with me that these beautiful researches of Angus Smith's very clearly demonstrate the influence of locality on the impurities of air, and are of striking interest and importance.

Let me next call your attention to the solid particles present in air, and to certain phenomena connected with them—especially fogs—not only the white fogs which we meet with over the sea and the country, but also the yellow and green fogs for which London and Manchester have acquired so unenviable a notoriety.

Mr. John Aitken has recently devised an instrument for counting the particles of dust in the air, and with it he has made a series of important observations in different places and under different meteorological conditions. Looking over his table I have made the following summary:—

| | Number of Observations. | Dust Particles per Cubic Centimetre. | |
|---|---|---|---|
| | | Highest. | Lowest. |
| COUNTRY. | | | |
| Kingairloch | 44 | 4,000 | 205 |
| Ben Nevis | 2 | 473 | 835 |
| Righi Kulm | 45 | 2,350 | 210 |
| TOWNS. | | | |
| London | 8 | 150,000 | 48,000 |
| Paris | 4 | 210,000 | 92,000 |
| Eiffel Tower | 15 | 104,000 | 226 |
| Dumfries | 38 | 11,500 | 235 |

I have only time to tell you some of the general conclusions which Mr. Aitken arrives at from his interesting researches. They are as follows :—

1. The earth's atmosphere is greatly polluted by dust produced by human agency.

2. This dust is carried to considerable elevations by the hot air rising over cities, by the hot and moist air rising from sun-heated areas of the earth's surface, and by winds driving the dusty air up the slopes of hills.

3. The transparency of the air depends on the number of dust particles in it, and also on its humidity. The less the dust the more transparent is the air ; and the dryer the air the more transparent it is. There is no evidence that humidity alone, that is water in its gaseous state and apart from dust, has any effect on the transparency.

4. The dust particles in the atmosphere have vapours condensed on them, though the air itself may not be saturated.

5. The amount of vapour condensed on the dust in unsaturated air depends on the relative humidity, and also on the absolute humidity of the air. The higher the humidity, and the higher the vapour tension, the greater is the amount of moisture held by the dust particles when the air is not saturated.

6. Haze is generally produced by dust, and if

the air be dry the vapour has but little effect, and the density of the haze depends chiefly on the number of particles present.

7. Some of the tests made of the Mediterranean Sea air show it to be very free from dust.

8. The amount of dust in the atmosphere of pure country districts varies with the velocity and direction of the wind; fall of wind being accompanied by an increase in dust. Winds blowing from populous districts generally bring dusty air.

9. The observations are still too few to afford satisfactory evidence of the relation between the amount of dust in the atmosphere and the climate.

The particles of dust in the air are intimately connected with the fogs of large cities, for London fogs "are produced by the mechanical combination of particles of water with particles of coal or soot, and require for their fullest development the following conditions: a still air, a temperature lowest at or near the ground in comparison with an elevation of some hundreds of feet; saturation, or partial saturation of the air (with moisture) within a moderate distance of the ground; absence of clouds overhead and free radiation into space. The artificial darkness and peculiar colouring occur with greatest effect at times when a very large quantity of coal is being burnt in domestic fire-places."—*Nature*, vol. 39.

"The formation of a London fog appears to take place as follows :—An ordinary thick white fog covers the city, say at 6 a.m.; about a million fires are lighted soon after this hour and the atmosphere becomes charged with enormous volumes of smoke, *i.e.*, the gases of combustion bearing carbonaceous particles. Now these particles, as soon as they are cooled to the temperature of the air, or below, begin to attract to themselves the water spherules already present and visible, and vapour may also be condensed on the particles. A thick layer of these united particles prevents light from penetrating it, and a very small quantity of finely divided carbon may stop the bright sunshine altogether like the film of soot on a smoked glass. This absence of light must tell decidedly on the vital force of the community, taken as a whole."—*Ibid.*

Then, too, we find that the quantity of carbonic anhydride rises to a very high figure—to as much as 10 vols. in 10,000 of air. The sulphur compounds and other products of combustion condensed in the water particles are extremely irritating to the lungs, so that we are quite prepared to learn that fogs are dangerous to life.

"In the great fogs of 1880 the death rate of London rose from 27·1, for the week ending January 24, to 48·1 for the week ending February 7, which was the period of thickest fog. In the

period of three weeks from January 24 to February 14, the excess of deaths over the average in London was 2,994. Probably ten times as many were ill from the combined effects of smoke and cold. The moral reaction of this atmosphere is well worthy of consideration. If smoke were got rid of there would be a great revival of plant vigour and human gaiety."—*Ibid.*

Then, too, consider the cost of these London fogs. Excluding the loss through stoppage of traffic, &c., each London fog costs, it is stated, in gas alone for illumination, £5,250.

It has been repeatedly urged that some very drastic measure should be taken for preventing the huge volumes of smoke, which cause these black fogs, from making their escape into the air, but legislation on the subject would be extremely difficult.

It is not within my province to speak of the exact nature of dust particles further than to say that some are merely pulverized minerals, others, the debris of plants and animals, while others again are the spores of low forms of vegetable life, such as moulds and bacteria.

I must leave the task of tracing the effects of the two last—both beneficial and deadly, to my colleague, Dr. Sinclair.

I shall conclude this lecture with a few elementary facts connected with ventilation.

Every adult man uses up about 20 cubic feet of oxygen, and exhales about 16 cubic feet of carbonic acid in 24 hours. By exhaling that amount of carbonic acid he vitiates about 400 feet of air.

A candle produces three-quarters the amount of carbonic acid which a man does in a corresponding time, and a strong oil or gas lamp five times the amount.

To ensure healthy respiration it has been held that each person should have at least 3,000 cubic feet of air per hour. With fair ventilation the air may be changed four times an hour so that in a well ventilated building about 800 cubic feet of space per head should be allowed—apart from allowances for candles or gas.

Next, to bring home to you the consumption of air by a number of human beings—

"During a two hours' meeting 2,000 people will give off about seventeen gallons of water from the lungs and skin and as much carbonic acid as would be produced by burning a hundred weight of coal." So you will readily understand that unless good ventilation exists, the air in a crowded room soon becomes poisonous.

Before speaking of ventilation allow me to bring forward the following statistics to illustrate the effects of impure air on health—the results, taken as a whole, being to produce general debility,

bronchial affections, and phthisis or consumption:—

From 1834-1847 the death-rate in a badly ventilated prison in Vienna was 86 per 1,000, of which 51·4 were due to phthisis, while in the well-ventilated house of correction in the same city the death-rate was 14 per 1,000, of which 7·9 were from phthisis.

I might bring forward many other statistics to prove the same point, but I think they are unnecessary, for everyone now allows that good ventilation of all buildings is an absolute necessity for health. And not only so, but also thorough cleansing by washing with soap and water, as well as scrubbing and rubbing of floors, furniture, and, when possible, of walls also. For it must be remembered that some of the organic matter, etc., evolved from the lungs and the skin, and also the solid particles from the air, including the spores of moulds, etc., are deposited on the surfaces of the rooms and furniture of our houses. These give rise to the close and peculiarly disagreeable smell often noticed in dirty rooms which have been shut up—especially in damp weather, when the moulds and mildews germinate, and may often be seen growing on any porous surfaces.

The last point I shall touch upon is ventilation, and I only have time to do so very briefly.

The ventilation of an ordinary room depends

upon the entrance of fresh air through the doors and windows (or through their crevices when they are closed), while the foul air escapes up the chimney; and for this reason rooms without chimneys and with double windows, or with the register of the grate closed, are unhealthy.

The great difficulty in the matter of ventilation is to keep up a proper current of air without draughts, and I may tell you that a draught is caused by an air current of a greater speed than eighteen inches per second.

To avoid draughts Tobin's system of ventilation is of great service. It consists in admitting fresh air through vertical tubes about seven feet in height, which are fastened to the wall inside the room and communicate with the outside at the level of the floor. Fresh air passing from the outside through these tubes into the room is projected vertically towards the ceiling and falls slowly downwards.

Finally ventilation occurs, to a certain extent, through the walls of a room unless they are painted, for bricks and plaster are porous, and it can easily be proved that air passes readily through such materials.

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*Appendix.*—At the close of the above lecture it was pointed out to me that I had omitted all mention of atmospheric ozone. I gladly make

good the omission in this note which I may preface by saying that both peroxide of hydrogen and ozone probably occur in air, but unfortunately we have no reliable test for distinguishing between them.

Andrews and others proved the presence of ozone in air which appears never to exceed 1 vol. in 700,000 of air. There appears to be more in Spring than in Summer, and more in Summer than in Autumn or Winter. It is also more abundant on rainy than on fine days. Its presence (in the Northern Hemisphere) appears to be favored by W. and S.W. winds, and its occurrence is largely dependent on atmospheric electricity—its amount increasing after thunder storms. The oxygen evolved from plants also contains small quantities of ozone. As a rule then, it occurs chiefly in sea and country air, and not in that of houses or dwellings, where it is, no doubt, destroyed by smoke, organic matter, etc. It has been stated that atmospheric ozone destroys air germs.

# HEALTHY HOUSES.

By JOHN W. BYERS, M.A., M.D.

AT the International Congress of Hygiene, held in London last August, at which delegates from all parts of the world were present, the Prince of Wales, who presided, in his inaugural address said, " Where could we find a family which has not in some of its members suffered from typhoid fever, or diphtheria, or others of those illnesses which are specially called "preventable diseases?" And he put a question which is of the greatest interest alike to you, as representing the general public, as well as to those who, like myself, are entrusted with a share in the preservation of the health of the public. " Where," said the Prince, "is there a family in which it might not be asked, if preventable, why not prevented?"

That already considerable progress has been

made in the prevention of disease, will be evident to every reflecting mind. Let me bring before your notice a few examples which show what has been accomplished, and I think you will all admit that in her attempts, not merely to cure, but to prevent disease, Medicine takes her highest, her most patriotic, and her most unselfish position. I shall first consider two diseases from our own country, Ireland, one of which, Leprosy, was very common in former times, but is now as an endemic disease absolutely unknown (the man at Lisburn to whom so much public attention has been drawn quite recently, having acquired the disease while in India); while the other, Typhus fever, is rapidly becoming extinct.

*Leprosy.*—My attention has been specially drawn to the existence of leprosy in Ireland in former times, from the fact that in August, 1890, I was requested by my highly-valued friend and respected teacher, Mr. Jonathan Hutchinson, (the late president of the Royal College of Surgeons of England), who is admittedly one of the highest living authorities on this disease, to get him all the information I could on the question. The results of this interesting investigation I have embodied in a memorandum from which I give the following facts:—

There is a tradition by one of his biographers that St. Patrick, Ireland's patron saint, had a

leper living in his own house, and that he attended him personally. In the seventh century it would appear that the monks were almost the sole medical practitioners, and the disease they were called upon most frequently to treat was leprosy. From the time of St. Patrick, onward to the middle of the seventeenth century, there are frequent references to the disease, to its great prevalence, and to its high mortality. However, about the middle of the seventeenth century Leprosy had almost disappeared, as Dr. Gerald Boate, in his most interesting "Natural History of Ireland," a book to which I shall again refer, tells us that in 1652 (when the first edition of his publication appeared) "it (Ireland) hath been almost quite freed from another disease, one of the very worst and miserablest in the world, namely, the leprosy, which in former times used to be very common there, especially in the province of Munster (the which, therefore, was filled with hospitals expressly built for to receive and keep the leprous persons), but many years since hath been almost quite freed from this horrible and loathsome disease, and as few leprous persons are found there as in any other country in the world; so that the hospitals erected for their use, having stood empty a long time, at length are quite decayed and come to nothing."

In the year 1775 there was one leper in the

Waterford Leper Hospital, and this is the last instance recorded in Ireland of the disease occurring endemically.

Joyce, in his "Irish Names of Places," shows that we have direct references to leprosy in several of the local names in Ireland. In particular he mentions the Irish word *Lobhar*, which, while in early periods it may have had a second meaning, was undoubtedly in later times applied specially to one affected with leprosy. When the word was anglicised it took the forms: *lour*, *lower*, *loura*, and *lure*, and Joyce thinks that whenever a name containing this word is met with, we may infer that some form of asylum or hospital for lepers was established there. Thus Knockaunalour, in the parish of Ardnageehy in Cork, means the little hill of the lepers. In Cork, Tipperary, and Galway, there are spots called Gortnalour, Gortnalower, Gortnaloura, the field of the lepers; in Clare there is a place called Paulnalour, the leper's pool or hole; Ballynalour, the town of the lepers, is a townland near St. Mullins, in Carlow. Further, the visitor to Dublin often hears of Leopardstown, situated between that city and Bray near Stillorgan; originally it was Ballylower, this became Leperstown, its present name Leopardstown, being a corruption.

The strongest proof, however, of the great prevalence of leprosy in former times, especially

in the middle ages in Ireland, is to be found in the evidence which we have of the existence of leper hospitals in different parts of the country. These hospitals were frequently associated with monastic establishments, probably because such institutions were, at these times, storehouses of medical, as well as of other learning, and the monks were often practitioners themselves of the healing art. I have been able to find evidence showing that leper hospitals existed formerly in the following places:—Carrickfergus, Downpatrick, Kilclief (at the entrance to Strangford Lough), Dublin (Stephen's Hospital), Leopardstown, Waterford, Wexford, Cork, Galway, and Armagh.

Various causes have led to the disappearance of this disease in Ireland, among which improved hygienic conditions, less overcrowding, and probably better food, have contributed their share. No doubt the ultimate cause of leprosy is a micro-organism, the *bacillus leprae*, but these other factors have acted as pre-disposing causes. It is worth noting that while Mr. Hutchinson thinks the eating of fish in a state of decomposition plays an important role in the causation of the malady, Dr. Gerald Boate wrote in 1652 that the prevalence of the disease in Ireland was due to the devouring of salmon out of season. When the English conquered the country, they made

strict game laws preventing this practice, and hence Boate thinks the disease disappeared.

*Typhus Fever.*—Some of the older members of my audience may have had a more than theoretical acquaintance with this disease, which formerly was very common in many parts of Ireland. Dublin used to be full of it, and it was well known in Belfast. From its frequent occurrence in Ireland it derived one of its synonyms, "Irish Fever"; and when our countrymen going over the Atlantic conveyed it with them, it acquired the names—"Emigrant" and "Ship Fever." It is very infectious, and few medical men here escaped taking it; so much was this the case, that in the year 1847 alone, it was calculated that no fewer than five hundred medical men in Ireland, or about one-fifth of the total number suffered from typhus of whom one hundred and twenty seven died. In Belfast some of our most promising medical men succumbed to the malady. At the present time the disease is much more rarely met with; indeed, in 1891, only four deaths were registered in Dublin from typhus fever, and in our own city it is now so infrequent that many of our younger doctors have rarely seen the disease. It has, I think, been clearly proven that typhus is due to overcrowding of people, with deficient ventilation, and that it prevails specially in times of famine and destitution. The working

classes are now better housed, they attend more to ventilation, and take better food—hence they suffer less from typhus. In Belfast the disease used to prevail in the small streets adjoining what was then called Hercules Street, and in the places close to where the present Free Library is built. The improvements in this portion of Belfast, necessitating the removal of a number of old houses, have had a large share in the extermination of the disease. I remember an old dispensary doctor (who was ahead of his time) telling me that it was a common disease when he was in his early years of practice, and that when called to people suffering from it he was always most careful to get the rooms in which they were lying well ventilated; this he managed by breaking holes in the windows. My friend, who was an advanced sanitary reformer, evidently believed in the old saying, "If you open the windows more you will keep the doctor from the door."

*Cholera* is no longer dreaded in these countries as in former times. In 1865-66 it appeared for the last time as an epidemic, and the death-rate then was less than in its former visits. The fact that it has not gained any hold in England since this date is, no doubt, due to the better sanitary arrangements with which it has to contend.

My own experience is that *Scarlet Fever* is not such a serious or fatal disease now as it was in years

gone by, and this may in part be due to the fact, that owing to the better drainage of our houses the severe forms of diphtheritic throats formerly met with in the course of the disease are now rarely encountered.

There is, perhaps, no disease in which we are all more interested than *Consumption*, for how rare is it to find a family or large connection of people free from its ravages. Science has taught us that it is caused by a bacillus, and we were all in hopes that last year we had, through the researches of Koch, found a cure for this wide-spread malady. For the present Koch has not succeeded; and our methods must continue in the direction of the prevention of the disease, and in using measures to enable the system (in the case of those affected) to conquer in the struggle between it and the bacilli. Even in this disease which, it was reported so far back as 1858, killed 50,000 people every year, preventive medicine has made considerable progress by the work of two independent observers, who have demonstrated the curious fact, that in towns where the soil has been drained, the death-rate from phthisis has fallen. Dr. Buchanan, in England, showed that in towns like Salisbury and Rugby where, owing to drainage works, the subsoil was dried, the mortality from consumption became less, to the extent of from 40 to 50 per cent.,

while in Morpeth and Ashby it remained the same, although there also, sanitary arrangements had been carried out, which did not however, effect drying of the subsoil. Liverpool also, from the same cause, shows a lower death-rate than formerly from this disease. Dr. Bowditch, of America, who devoted considerable attention to this question of the relationship of a damp soil to phthisis, made the following statement :—" A residence in or near a damp soil, whether that dampness be inherent in the soil itself, or caused by percolation from adjacent ponds, rivers, or meadows, marshes, or spongy soils, is one of the principal causes of consumption in Massachusetts, probably in New England, and possibly in other countries of the globe. Consumption can be checked in its career, and possibly, nay probably, prevented in some instances by attention to this law."

*Puerperal Fever.*—Let me bring before your notice one other example which shows the highest triumph which preventive medicine has yet obtained—puerperal fever. You all know the terrible mortality of this disease, and the loss and calamity it brings, not only on the family afflicted, but on the medical attendant. Speaking of such cases, the brilliant "Autocrat of the Breakfast Table," Dr. Oliver Wendell Holmes, one of the professors in the medical faculty at Harvard, has said :—" No tongue can tell the heart-break-

ing calamity they have caused; they have closed the eyes just opened on a new world of love and happiness; they have bowed the strength of manhood into the dust; they have cast the helplessness of infancy into the stranger's arms, or bequeathed to it, with less cruelty, the death of its dying parent. There is no tone too deep for regret, and no voice loud enough for warning. The woman about to become a mother, or with her new-born infant on her bosom, should be the subject of trembling care and sympathy wherever she bears her tender burden, or stretches her aching limbs."

In former times (the end of the last and the first half of the present century) the mortality in lying-in hospitals both in Great Britain and the Continent was extremely high. It reached 34 per 1,000, nearly 7½ times higher than in private practice. This increased death-rate in maternity charities was found to be due chiefly to the existence of puerperal fever which caused 75 per cent. of the deaths. The attention of the profession was directed to the elucidation of the question as is evidenced by the fact that between the years 1854 and 1874, more than 20,000 pages of material had been published on the subject. The first distinct step gained was the establishment of the fact that puerperal fever was infectious, and that it might be carried from one patient to

another, and that in its essence it was a form of blood-poisoning depending on the presence of micro-organisms, and that if these germs could be prevented gaining ingress to the bodies of women at the time of childbirth, the disease even in lying-in hospitals could be prevented. This has been accomplished by the systematic adoption of antiseptic precautions, as the following most interesting statistics show, taken from three different countries. In the Imperial Lying-in Hospital, Vienna, during 1857-62, the mortality was 28 per 1,000; in 1881-85 (antiseptic era) it fell to 7; in 1863-80 the death-rate from puerperal fever was 13 per 1,000; in 1881-85 it fell to 4.

In La Maternité, at Paris, the visitor is shown a linear chart on the wall, giving the total death-rate of the women confined there from 1792 to 1886. It is divided into three periods. There is first the period of inaction (as it has been called) with a mortality of 9·3 per cent., sometimes reaching 20 per cent. Then comes the second period in which general hygienic measures were adopted, such as ventilation, drainage, and avoidance of overcrowding, with a lessened death-rate of 2·3 per cent. Then comes the third or antiseptic period in which the precautions, known as antiseptic, were adopted with the result that the mortality was 1·1 per cent., and not even that, in 1885-86. In an extremly interesting clinical

lecture just delivered, December, 1891, by M. Tarnier, Professor of Obstetrics, at the Paris Faculty, he gives the statistics of his ward for the the past year. Out of 1,340 confinements only 14 deaths occurred, a mortality of 1 in 95, or 1·04 per cent. Eight years ago the mortality calculated on the same number of cases was 2·50 per cent.; while thirty years ago one parturient out of eleven, or 9 per cent., died. These figures, he shows, prove that in his ward alone, the modern methods used in obstetric practice, have saved 100 lives per annum. Puerperal fever is a disease now unknown in his wards, for of the fourteen fatal cases not one died from it. This is all the more remarkable as Professor Tarnier tells us he remembers in the pre-antiseptic age, having witnessed the deaths of five women in the same day from Puerperal Peritonitis.

Up to the year 1877 (as Dr. Priestly has shown in his valuable paper "On the Improved Hygienic Condition of Maternity Hospitals,") the General Lying-in Hospital in York Road, London, was hardly ever free from puerperal fever. At great expense the drainage was improved, and other sanitary arrangements were carried out, but it was not until 1879, when the antiseptic precautions were thoroughly put in force, that a complete change took place. The total mortality, which was 30.8 per 1,000 from 1833 to 1860, and 17 per 1,000

from 1861 to 1877, has since fallen to 6 per 1,000, and in three years there was only one death from puerperal fever. Dr. Priestly has shown that comparing the death-rate in Maternity Hospitals since 1881 (after the introduction of antiseptics) with what it was formerly, no less than 3,011 lives of mothers have been saved as the result of this new scientific method of treatment. As he well says—"This may fairly be stated to be one of the most striking triumphs of preventive medicine."

It has been calculated that in England one-fourth of all the mortality is due to preventable diseases, and Sir Joseph Fayrer believes that 125,000 die yearly from preventable disease, and he has computed that, when one takes into consideration the large number of cures for every death, 78¼ millions of days of labour are lost annually, which means £7,750,000 per annum; and this, he says, does not include the days lost by the exhaustion so often induced by the still too numerous unhealthy homes of the poor.

Many forms of preventable diseases originate in unhealthy houses, and although matters now are very much altered from what they were in the time of Queen Elizabeth, when "the homes of the people were wooden or mud houses, small and dirty, without drainage or ventilation, the floors of earth, covered with straw or rushes, which

remained saturated with filth and emitting noxious miasmata; the streets narrow and unpaved, with no drains but stagnant gutters and other cesspools," there is still great room for improvement.

At present the most glaring defects are likely to be found in old houses, especially in their sanitary arrangements, and no one should take an old house unless its sanitary arrangements have been thoroughly overhauled and re-arranged on the principles now accepted as correct by experts. As to new houses, there is no excuse, as they should all be made, as far as their construction goes, perfectly healthy.

Instead of giving an elaborate account of what a healthy house should be, I propose to look at the negative side of the question and to consider the subject of unhealthy houses. Now when any of you in a time of illness calls in your medical attendant, he first endeavours to find out what symptoms you complain of, he then carefully examines you, and, having done so, gives directions as to your treatment and as to how you may prevent yourself in the future suffering from a similar attack of ill-health. Let me in the same way ask you what are the symptoms which would lead you to suspect that your houses are unhealthy? These may be arranged under four heads:—

I. The existence of Dampness; II. The pre-

sence of foul air or smells; III. The visitation of rats; IV. The occurrence among the dwellers of certain types of disease.

I. *Dampness.*—How does a house become damp?

1. By being built directly on a damp soil. You know that at a certain point below the surface in ordinary soil, all the interstices are filled with water. Now at or below this level we have a continuous sheet of water, called the sub-soil or ground water. In very damp localities the sub-soil water may be on a level with that of the ground itself, but as a rule it is from two or three to a hundred feet or more below the ground. It flows usually towards the sea or the nearest water course. Above the level of this ground or sub-soil water, the earth is kept moist by capillary attraction as well as by evaporation from below, and by rainfalls and the movements of the ground water. The soil loses moisture by evaporation from the surface. Now if you take a walk along the basement passages of some of our city houses, or if you examine the rooms on the ground floor, you may notice the flags or stone pavements damp, and you may see indication of wetness on the walls. In a house not far from where I live I saw a most luxuriant growth of fungi on the floor of a pantry. This dampness is owing to the fact that the flags rest directly on bare earth with no ventilating space underneath; and it is to

be obviated, if the ground is very damp, by draining the sub-soil of the site of the house—just as a farmer drains his field—by suitable earthenware pipes, which must, however, have no direct communication with the drain pipes for sewerage. In every house the basement must be covered with some impermeable material to keep out the dampness as well as the ground air. A layer of concrete, faced with cement or asphalte, at least four to six inches thick will do well, and it should extend for two or three feet all round. The ground should have previously been levelled properly. It is well to lay the joists so as to leave a foot of space between the concrete and the floor, and gratings are to be inserted in the walls to give a free circulation of air. Through the want of these gratings I saw the floor and joists of a room, of an otherwise well-built house, in a condition of "dry-rot." I often observe in Belfast unhealthy rubbish heaps, with notices up, "Rubbish taken here;" and often long before the refuse, animal and vegetable (frequently with the germs of disease) has had time to cease to be poisonous by fermentation and decomposition, houses are erected on this improper foundation. These made earths, which are always suspicious and often deadly, should never be built on for at least three years after formation, and not even then unless they have

been thoroughly drained and covered with some impermeable material. It is said the most healthy soils are granite, metamorphic, and trap, chalk, sandstone, deep high-lying gravel, and stiff well-drained clay.

2. A second cause of dampness is moisture from the ground, which, owing to capillary attraction rises on the walls to a height of ten, or even in some cases, thirty feet. It is to be prevented by the introduction of what is called a damp-proof course through the whole thickness of the walls above the highest point of contact with the ground. A layer of asphhalte or pitch, or slates embedded in cement, or specially-glazed tiles may form this damp-proof course. In country houses, or in houses in towns built in the suburbs, you may at times notice the walls at the back of the house damp. This is owing to the earth abutting directly on the end walls and imparting its moisture to them, and it is to be prevented by making a space between the house and the garden, or earth, with a ventilation between.

[These various defects, with their remedies, were then explained by means of diagrams.]

3. A house may also become damp by rain getting an entrance through defects in the construction of its various parts, as for example, in the roofs, windows, window-sills, dormers, rain-water pipes, etc.

4. A very serious form of dampness is when it arises from leakage in a soil-pipe; it needs immediate attention.

It is a curious fact that the mortality of some of the acute fevers is increased by dampness of the soil. Dr. Blaxall has shown that in Swindon, while there is full intercourse between both parts of the town, measles, whooping-cough, and pneumonia, were twice as fatal in that part of the town built on the Kimmeridge clay as in the other part which is situated one hundred feet higher on the limestone and Portland sand. Again, Dr. Murphy tells us that ague, which used to be common in London, south of the Thames, has with the better drainage of the land, almost entirely disappeared. The diseases specially predisposed to by dampness, are colds, coughs, rheumatism, sciatica, neuralgia, and consumption.

II. *Foul Air or Smells.*—A house may become vitiated by impure air in several ways.

1. Through want of proper ventilation the rooms of a building, in other respects properly constructed, may become unhealthy. If you go into a crowded meeting you will see this illustrated in an exaggerated degree; and it is often noticeable in the bedrooms of houses, in the eating-rooms, and I am sorry to say too often in the nurseries, where, at times, the habit of drying various articles (sometimes themselves impure)

tends to add still more to the impurity of the atmosphere. On the question of ventilation I will say nothing further, as it has been so ably discussed by Professor Letts in his lecture "On the Air we Breathe."

2. The earth contains ground air, which may become impure through the house being erected on artificial or made soils, or from the soil being contaminated by discharges from drains and cess-pools of the house itself, or through the air travelling in currents from the vitiated soil of the house of a neighbour at some distance from the one in which you are living. The cure for all these defects is the same. Never build a house directly on the soil, but always first cover the foundation with some impervious material like concrete, so as to keep out the ground air.

3. I wish to bring before your notice the most likely way in which foul air or smells may get into houses and that is through defects in the drainage system allowing escape of the impure gases. In sewers and drains foul air is always present, arising from the decomposition of putrescible materials. If these get into places where they are not flushed away they decompose, producing foul air. How does this foul air find its way into houses?

(*a*) Through the use of bad appliances.

(*b*) Owing to "scamped" work, or where

good appliances are not properly arranged.

(*c*) Through over-use appliances get worn out and defective.

(*d*) Owing to the disuse of such things.

The essentials to be aimed at in the sanitary arrangements of our houses are, according to modern ideas, two-fold—first, to get rid of every form of nuisance from the house as rapidly as possible, and, at the same time, to prevent any escape of foul air into the house either from the drains of the building or from the main sewer where it is joined by these house drains. Bearing in mind these two most necessary provisions, let us see how they can be carried out in practice.

1. *Structure, size, and situation of the house drains.* They must be made of some non-pervious material. Glazed, socketed, earthenware pipes are the best, and they should be thoroughly sealed at the joints to prevent any escape of their contents. In many old houses we find the drains made of porous brick, which allow the impure air, and often the foul water, to come out of them; or the drains are made of brick and mortar, which are not only porous, but may, in fact, fall in, and so leave places for escape of their contents. I have seen these brick sewers in some of the old houses in Belfast, and in one which was being overhauled recently, their dreadful condition showed that the house was sitting on a cess-pool. It is

little to be wondered at that the family were rarely well! As to size, it is a mistake to use too large drain pipes, but this will vary, to a certain extent, with the size of the house. A drain-pipe whose diameter is six inches will do in a very large majority of cases; for it is to be remembered that the smaller the pipe the less the friction, and the greater the hydraulic pressure the more rapid the flow of the current. A familiar instance of this you will all have noticed in looking at the increased velocity of a stream when it passes with diminished size through a bridge. As to situation; there is a rule which must, if possible, always be carried out, and that is—that no drains should be located beneath the house. Unfortunately in town houses this rule owing to the position of the main sewer cannot always be adhered to. In such cases the drains should be encased in concrete.

2. *General plan of arrangement of the drains.*—The drain-pipes must be laid on a solid foundation of concrete, otherwise, through displacement by sinking of the earth, the joints will cease to keep in the contents. They should be in straight lines, and whenever this is departed form, man-holes should be constructed, so as to allow inspection of the pipes, and the junctions of pipes should be curved not right-angled. Where several drains join, an inspection chamber with man-hole, is necessary. Further, the drains to be emptied

must have a fall, and one of four inches to ten feet will do. Where, owing to various circumstances, it is not possible to get sufficient fall for the drain-pipes, and especially in large establishments, as hotels, or schools, arrangements should be made for the regular flushing of the sewers, and in such conditions an automatic flushing cistern is very useful. There is one point of very great importance which is, I am afraid, too often neglected, that is, the thorough testing of the drains before they are covered in. This is the time to see that they have a proper fall, and (by closing the lower end and filling them up with water) to make certain that the joints are not defective.

Having pointed out how the house drain-pipes should be properly arranged, the next problem to be solved is how to prevent the ingress of foul air from the sewer. This is done by what is known as "disconnection" and ventilation. In its simplest form it can be managed as follows:—At some place between the house and the main sewer a disconnecting trap is placed. Buchan's, the one commonly used, is U shaped. The water in the syphon trap opposes the entrance of air from the sewer. On the house side of the trap there is an inlet for taking in fresh air. The next thing is to be careful that the soil-pipe is carried up of equal diameter throughout above the roof,

and a cowl on its summit will facilitate an up-current. The fresh air entering at the inlet on the house side of the syphon-trap, courses through the house-drains and up the soil-pipe, and hence they are ventilated. The syphon-trap prevents the sewer-gas entering the house-drains, and should the pressure on the sewer side be so great as to force the air through the water in the trap, or should it be drawn in by the heated atmosphere of the house, the air inlet will cause its diffusion and no harm will accrue.

It is now an accepted axiom in sanitary science that a man-hole made of brick should be built on the house side of the syphon trap. At the bottom of this there are open channels, through which the drainage of different parts of the house must pass before entering the syphon trap. The construction of man-holes, or inspection chambers, at different points in the drainage system of houses is of the greatest importance, especially at points of junction of several drains. The contents of the drains pass through open spaces in these chambers, and by holding a lighted candle in the bottom of the drain in the man-hole, and looking from one chamber to another one can easily see if there is any obstruction. If they do get blocked they can be cleared by using a form of "rod," very similar to that employed by sweeps in chimneys. The soil-pipes should be most carefully

arranged. As to situation, they must always be ontside the house, and in structure drawn lead is said to be best. Great care must be taken that the junction of the soil pipe with the closet is perfect, and that it is carried up above the roof in full sectional area, and below it should always work in connection with a disconnection chamber with its fresh inlet between the syphon-trap and the house drain. As to the closet, it should be against the outer wall of the house, and the simpler it and all other sanitary fittings the better. Little woodwork should be used, and all such appliances are to be constructed so as to allow of being easily inspected and cleared. The principles aimed at in the construction of closets are to have a simple basin and syphon, the latter being cleaned each time of use by a sufficient flush of water supplied from a cistern used for nothing else. The "Unitas" seems to fulfil all these conditions, and is very simple in its structure.

*Sinks, Baths, and Lavatories.*—The waste-pipes from sinks, traps, housemaids' closets, and lavatories should always be trapped, and should never open direct into the drain or communicate with the soil-pipes. All these pipes should be provided with a syphon-trap, and they, as well as the rain-water pipes, should open into or above a trapped gulley grating. In many houses, especially large ones, a grease-intercepting chamber

is erected in connection with the scullery sink.

*The Cistern.*—The overflow pipe should always discharge into the open air and never into the soil pipe, as I have seen, or directly into the drain. In a house where the children had attacks of sore throat, I found the cistern overflow pipe opened direct into the main drain, and so foul air entered the water and poisoned it. A correction of this glaring defect was followed by a cessation of the illness of the children. Further, the water for the closet should never be drawn direct from the main cistern. I show you here two diagrams taken from Mr. Teale's book, on "Dangers to Health." In the one you see a house with every sanitary arrangement faulty. The wäter closet is in the centre of the house, while the house-drain is under the floor of a room. The waste-pipe of the lavatory is untrapped and passes into the soil-pipe of the closet. The overflow-pipe of the bath is untrapped and enters the soil-pipe. The waste-pipe of the bath is untrapped and passes into the soil-pipe. The save-all-tray below is also untrapped and opens into the soil-pipe. The kitchen-sink is untrapped and passes into the soil-pipe. The water closet cistern has its overflow opening into soil-pipe of closet, thus ventilating the drain into the roof, polluting the air of the house, and the water in the cistern, which also forms the water-supply of the house for drinking,

etc. There is a rain-water-tank under the floor with overflow into the drain. There is a fall-pipe conducting foul air from tank fouled by drain-gas, and delivering it just below a window. There is a drain under the house with uncemented joints leaking; also a defective junction of vertical soil-pipe with horizontal drain. The drain has no proper fall. In this other diagram you see a house with such faulty sanitary arrangements avoided. The closet is against the outer wall of the house, with soil-pipe passing directly out of the house, and ventilated by a pipe continuing the soil-pipe above the eaves, and away from chimneys or windows. The house-drains are entirely outside the house, the lavatory, overflow of bath, waste-pipe of bath, save-all tray of bath, and kitchen-sink, are all trapped and disconnected from the drain, and discharge into an open gully trap. The overflow of cistern is into the open air, the fall-pipe near the bed-room window discharges into the gully, and the domestic cistern is distinct from the closet cistern. Here also is a model house (lent me by Mr. Richard Patterson, J.P., through whose kindness I have been able to show these other sanitary appliances) in which you will see all the sanitary fittings needed in a house according to the most recent methods suggested by sanitary engineers.

[Dr. Byers then explained these appliances as exemplified in this sanitary house.]

In case you are in doubt about the condition of the drains of your houses, there are two plans by which they can be tested. One called the smoke test is applied at the lowest part of the drain; if a special opening cannot be made, a trap can be taken out and the sewer end will need to be plugged. The smoke can be pumped in by a special apparatus, or a "smoke-rocket," can be lighted and passed into the drain, the opening being covered with sacks. A thick volume of smoke fills the drains and bursts through defects, if there be any. The other test (the peppermint one) needs two persons, one of whom pours two ounces of oil of peppermint into the highest part of the drain, and then a few buckets of boiling water. He carefully closes all doors and windows to prevent the odour entering the house except by defects in the drain. His companion goes along the course of the drains and any smell of peppermint indicates some defect.

Every householder should have a plan of the drainage system of his dwelling.

One other point may I add. Never take a house until you have its sanitary and other arrangements thoroughly examined and reported on by an independent expert immediately before you enter on occupation.

III. *The Presence of Rats.*—When rats appear in a house it is an indication that the drains are out of order. In country houses they, as a rule, come from the farmyard, but in towns they emerge from the sewer. In old brick drains, holes are formed by the falling in of worn-out bricks from the roof, and it is often through these the rats enter the house. Again, by making runs beneath badly jointed pipes they let them down, and so cause escape of foul air; indeed, their principal source of danger is that wherever they go the foul air from the drains can follow them; and as they generally make their way to the pantries, they may, by taking a certain amount of filth with them, contaminate any food they attack. At times (as I have seen), by making their way into the cistern they pollute the water supply of the house.

IV. *The occurrence amongst the dwellers, of certain types of disease.*—The diseases apt to be associated with damp houses I have already mentioned; they are colds, coughs, rheumatism, neuralgia, sciatica, phthisis. Those which are liable to arise when there are defects in the sanitary arrangements are certain forms of sore throat (of a diphtheritic type), typhoid fever, diphtheria, diarrhœa, attacks of general malaise, and depressed vitality. Children are specially liable to suffer when the houses are un-

healthy; indeed, they may be regarded as health-barometers, and depend upon it there is often something amiss with a house when the children are constantly ill.

*Situation, Prospect, Aspect, and Surroundings of Houses.*—While the question of the influence the various geological strata have on the healthiness of the site of houses is one of considerable interest, sufficient data have not, so far, been accumulated to enable us to speak with assurance. A curious fact has been cited by Mr Eassie, C.E.: "No less than nineteen of the largest and most important towns in England, from Exeter to Carlisle, are all situated along the line of one geological formation—the new red sandstone." The healthiness of the soil of dwellings depends on four factors, as the late Dr. Parkes has shown: 1. Considerable slope, so that water runs off regularly and the air is dry; 2. Vegetation not excessive; 3. Absence of organic emanations; 4. Purity of water supply. Mr. Eassie tells us that other influences besides that of the exact nature of the soil are of importance in their bearing on the health of individuals. "Districts which are situated on the coast and most exposed to the prevailing winds, and where the latter meet with the least obstruction, have the least mortality due to heart disease. Whilst these coasts on the South-East which present

barrier-like rocks which interfere with the full sweep of the sea breezes are to be identified with a high mortality."

London has a proverbially low mortality, no doubt due to its situation, good drainage, etc.; but as Eassie suggests, it may in part be due to the fact, that it is traversed by the Thames up the valley of which the winds can blow freely. I have shown before the relationship between the dampness of the soil and consumption, and after all the most important point to be attended to in the selection of the site for a dwelling is the wetness or dryness of the sub-soil. The two principal sub-soils are gravel and clay, and when there is a good gravel sub-soil it is sure to be a healthy foundation. In the country the best situation for a house is not the top or the bottom, but the slope of a hill facing between S.S.E. and S.W. This will have two advantages—sufficient fall for drainage, and protection from the East and North winds.

As to surroundings, if high hills are too near the town there is apt to be more than the average rain-fall, as we know in Belfast. There should not be any trees within some distance of a house, and sluggish water and ponds are to be avoided. I have come across a mansion where I feel confident that several attacks of illness were due to the existence of such stagnant water.

Ponds in the neighbourhood of town houses are specially objectionable from the fact that sewerage matter from adjacent dwellings is apt to find its way into them, and so become an active agent in spreading disease. A house built near the sea enjoys a more equable climate than one further from it where there is a greater range and more marked alternations. We all know how warm and genial the southern parts of our islands are in comparison to the cold and bleakness of the east coast, and the dampness of the west, exposed as it is to the Atlantic breezes, always surcharged with moisture. In city houses one has not often a great choice in the selection of the situation of a house, but "made-soils" are to be avoided, and before taking a house it might, as has been said, be worth while considering will you have as neighbours a place of public amusement, an hospital for infectious diseases, a cemetery, a mews, a public-house, or a grating for ventilating one of the city sewers? About our own city medical men are often asked what are the most healthy districts? On this matter the old proverb may be quoted, "Doctors differ"; but, speaking for myself, I think there are no better districts in the neighbourhood of Belfast than those of Newtownbreda and the Knock. The Board of Management of the Belfast Hospital for Sick Children, influenced by the opinion of their medical staff, selected

Newtownbreda as the site for the Queen Victoria Convalescent Home. I am well aware, however, as every medical man must be, that personal idiosyncrasies have to be considered in the selection of a district to live in, and thus it happens that one family will tell you they were always having illnesses until they came into a certain locality, while from another you will learn that until they left the same district they were often under the care of their medical attendant.

*Aspect and Prospect.*—It is sometimes difficult to obtain both a good aspect and pleasant prospect for a house, though both have much to do with its comfort. One wants to construct a dwelling so as to be able to enjoy any natural beauty in the surrounding scenery, but we have sometimes to sacrifice a good prospect even in a country house in favour of a good aspect; for no matter how delightful a northern prospect may appear, sunshine is absolutely essential to life; and hence, if both cannot be secured, the prospect should be abandoned rather than the aspect. A south-east aspect is the most desirable for the best rooms; such as day-rooms, nurseries, and apartments for an invalid; simply, because it is not exposed to a scorching sun, to east winds, or to a penetrating rain-fall.

*Water Supply.*—A good water supply is of the utmost importance to the health of a house.

In large cities, such as Belfast, there is likely to be less danger in this respect, owing to the care taken by the companies who provide it, than in the country districts, where the people get their water from wells, which are apt to be contaminated in various ways. In either case a careful analysis by an expert should be made from time to time, and more especially should there be any suspicion arising from illness or any other cause. In city houses the utmost care should be taken as to cisterns and the general water fittings. I have already shown how contamination may arise through the association of the fittings with soil-pipes and drains.

The cisterns which are usually made of wrought-iron, afterwards galvanised, should be placed in a room, easy of access, and never in the same apartment with a closet or bath-room. The over-flow pipe should deliver in the open air, and the closets (as I have pointed out) should be supplied by separate cisterns and not from the main one in the house. The cistern should be thoroughly cleaned at least twice a year. It is extraordinary the amount of material which will accumulate in the bottom of a cistern. After this is removed it is well to dissolve some permanganate of potash or to empty some Condy's fluid in the water which is first allowed to fill the cistern. After about an hour this is permitted to escape, the

cistern again flushed out, when the supply-water may be used. The service-pipes should always be easy of access in case anything goes wrong, and it is well to have a plan showing their situation in a house.

*Filters.*—As to filters, while their principal use is to destroy organic impurities, or make them harmless, the difficulty is that the cleaning of them is not done with sufficient frequency or care, and as it has been stated that "certainly filtering will not remove all traces of fresh sewage contamination," you must not rely too absolutely on their use.

It is marvellous to notice how advanced Shakespeare's views were on the important subject of water. You all remember the words he makes Macbeth use when addressing the doctor, he says:—

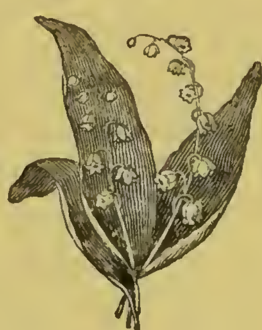
> "If thou couldst, doctor, cast
> The water of my land, find her disease,
> And purge it to a sound and pristine health,
> I would applaud thee to the very echo,
> That should applaud again."

While indicating as briefly as possible what are now considered essentials in the structure, site, and general arrangement of houses, I may be permitted to add these may all exist in perfection, but no matter what may be the construction, either of the villa of the merchant, or of the cottage of the working-man, neither can long

continue healthy unless under the vigilant eye and capable hand of the practical housewife. It is often urged as a reason why woman must take a lower place that she cannot go out as a soldier to fight the battles of her country. In our observation of life, however, we doctors soon learn that it is in the home where woman's battles are really fought and won; for with what innumerable enemies to moral and physical health has she often to contend in her own household, and in that place the observant, thoughtful woman will always be found the bravest, the most persistent, and most careful sanitary reformer. When she is enlightened, self-reliant, and capable, then, and then alone, can the health of the family be carefully attended to, by perfect cleanliness in every department, and by a sensitive quickness to foresee and detect those defects which are sure to arise in the most perfectly-planned house, just as illness sometimes seizes the strongest and apparently the most robust.

In the houses of the wealthy, all, that as a matter of daily routine, is connected with internal cleanliness, including proper attention to sinks and traps as well as to the ventilation generally, is, if left to the care of servants, through their ignorance rather than through their culpable neglect often omitted. Thus, the health of the family, and especially of the children, is

often seriously injured without any apprehension as to the cause. The mistress, who is no stranger in her nursery, her kitchen, in her pantries, and in other departments where men rarely intrude, is the one who, by her thorough management, brings life and joy to the household. Though she is not always credited with this power, I am more and more convinced, after the house is well erected, it is to woman's sound judgment and enlightened influence we must mainly look for the preservation of the health of the home.



# THE INFLUENCE OF MIND ON BODY.

By J. A. LINDSAY, Esq., M.A., M.D.

THE influence of mind on body is the subject which is to engage our attention to-night. It is a subject of absorbing interest and great practical importance. It is also one of immense difficulty, and I shall have to ask the indulgence of this audience while I attempt to handle, briefly and imperfectly, topics which have engaged the thoughts of the wisest and greatest of all nations and of every age.

Man seeks, before all things, to know himself, but he finds the quest of self-knowledge the most arduous to which he can devote his energies. As expressed in the fine line of Tennyson, he can

> "Rift the hills and roll the waters, flash the lightnings,
> weigh the sun,"

more easily than he can adequately determine the functions of a single brain cell. The special

difficulty that confronts us is the impossibility of fully defining what we mean by mind. Body we know—this wonderful frame-work of bone and muscle and blood-vessel, and nerve, so complex, so strong, so delicate; but what of mind? We can enumerate its functions, formulate its laws, observe its effects, but of its inner nature or essence we are ignorant. It would seem as if the human mind cannot fully analyse itself, any more than (to use a well-known illustration) a man can stand upon his own shoulders. And so the science of mind has remained comparatively barren, admirable as intellectual gymnastic, and most salutary in freeing us from dogmatism and error, but yielding little positive fruit.

I am anxious, to-night, to avoid all metaphysical subtleties, and to keep aloof, as far as possible, from controversial matter; hence, I propose to put before you a conception of mind and body which, though avowedly imperfect, will, nevertheless, serve the purposes of this lecture. Now, whatever may be doubtful on this subject, this much is certain, viz., that our nature has two aspects—the physical and the mental. The former relates to our bodily frame, with its bones, muscles, nerves, etc., and the animal or organic functions of circulation, respiration, digestion, excretion, etc. The latter relates to such phenomena as thought, memory, emotion,

imagination, will. These two aspects of our nature can be kept distinct in thought, but their relation is of the closest. It is probable, but not quite certain, that for every mental fact there is also a physical fact; that every thought or emotion of our minds is accompanied by some molecular change in the substance of our brains. This doctrine is not identical with Materialism, as it is quite open to us to hold that the physical change in the brain is the consequence rather than the cause of the mental phenomenon. Without embarking upon a sea of illimitable controversy, let me take this opportunity of endorsing Professor Huxley's emphatic pronouncement that "Materialism is the most baseless of dogmas." The older metaphysicians were very solicitous to define exactly the relation of mind to body, and their mode of co-operation. Hence arose the doctrine of Descartes, that the soul had its seat in the Pineal Gland, a view now universally discarded, the function of that gland being known to be much less august than that conceived by the great philosopher. Modern thinkers are much less ambitious than Descartes, and renouncing as insoluble the question of the precise mode of connection of mind and body, they content themselves simply with enumerating and describing the two sets of phenomena—the physical and the mental. The modern view is

best expressed by the dictum of Professor Bain, that "Man is a double-faced unity,"—a figure taken from a coin.

Such being the close relation of mind and body, two sets of phenomena engage our attention, viz., (*a*) those illustrating the influence of body on mind, and (*b*) those illustrating the influence of mind on body. Of the former many instances will readily occur to you. An injury to the head may impair, or if sufficiently serious, may entirely suspend the mental operations. Bodily fatigue impairs intellectual activity. Our memory, for example, often fails us when we are physically exhausted, and becomes active and efficient again after physical rest. A heavy meal makes us indisposed for mental effort—Nature's warning that after eating, the blood is required for the purpose of digestion, and must not be diverted to the brain by severe intellectual exertion.

Bodily disease has a great influence over the mind, a fact that finds record in many languages. The Greeks were not far wrong when they said the moody and dejected man was suffering from black bile—melancholy—affections of the liver being recognised sources of mental depression. Hence, the joke, both witty and physiologically exact, "Is life worth living? It all depends on *the liver*." The extraordinary hopefulness which frequently characterises the dying con-

sumptive is really, strange as it may appear, an instance of the influence of body on mind. The poison of tubercle obtaining access to the blood is carried to the brain, and exerts upon that organ the influence of an intoxicant. The gouty man is proverbially irritable, the excess of acid in his blood exercising a provocative influence upon the mind. Many facts unite to prove that the food we eat exercises an influence over the mind and disposition. The horse fed on oats is more high-spirited than when fed on grass. The cat, naturally a flesh-feeder, can be rendered tame and docile by a diet of vegetables. Man himself obeys the same law. The great and dominant races of humanity have been either flesh-feeders or nourished upon the nitrogenous cereals, while a diet of rice finds its mental consequent in the timidity and unwarlikeness of the Hindoo. Lastly, and most curiously of all, a severe illness such as one of the specific fevers, has been known to make a permanent change in the moral nature, changing, perhaps, hopefulness to despondency, cheerfulness to irritability, or, less frequently, perhaps, the converse. Such are a few of the facts which illustrate the vast influence of body on mind.

Let us glance now at the opposite side of the picture and consider the influence of mind on body. Of this the following examples may be

enumerated:—The will controls our muscles and exercises more or less influence over many of our bodily functions. Emotion affects the body and calls forth a form of physical expression which we have learnt to regard as appropriate. Thus, joy makes the eye to sparkle and the face to expand. Grief contracts the brow, puckers the mouth, and excites the secretion of the tear gland. Shame causes the cheek to mantle with a blush. Fear blanches the countenance. Emotion, again, may render us quite insensible to pain. Soldiers, amidst the roar and excitement of battle, are often unconscious of the impact of a bullet. Martyrs have died at the stake, apparently without suffering, religious ecstasy controlling and annulling physical torture. The influence of emotion on digestion is well known; the favourable effect of cheerful society and agreeable conversation promoting digestion on the one hand, or, on the other, bad news, or a fit of passion, producing a violent attack of dyspepsia. It is a well authenticated fact, that profound grief or severe shock may whiten the hair in a brief space of time, a phenomenon to which Byron alludes when he makes the prisoner of Chillon say—

> "My hair is grey, but not with years,
> Nor grew it white
> In a single night,
> As men's have grown from sudden fears."

This is a very marvellous fact which has deeply impressed the imagination of humanity.

Further instances of the influence of mind on body are furnished by such facts as, that when giving fixed attention to any subject we habitually restrain the breathing. Watch a lady threading a needle—an operation too delicate for the coarser masculine manipulation—she will be found habitually to hold her breath when engaged in the little operation, and then to breathe deeply when it is successfully accomplished. The tyro's first speech furnishes another good instance of the influence of mind on body. He rises full of information and fancied eloquence, but his knees knock together, his tongue cleaves to the roof of his mouth, strange sparks dance before his eyes; and, very probably he murmurs a few incoherent sentences, and sinks into his seat exhaused by the effort. When the doctor examines the pulse of a nervous patient he often finds it racing with extraordinary rapidity, simply from excitement, and is compelled to allow time, and to test it repeatedly before he can accurately determine its actual frequency. The good effect of hopefulness upon health is another instance of the influence of mind on body. Lastly, the phenomena of mesmerism, hypnotism, faith-healing, and the like, are sufficiently accounted for by the influence of mind on body without invoking any other hypothesis.

I have said that of mind, as an entity or essence, we know nothing. We can only enumerate its functions or faculties. I propose, now, to take these functions in order, and point out in somewhat greater detail their influence upon the body. The principal functions of mind are the following:—

I. Thought.

II. Will.

III. Emotion.

IV. Imagination.

I. The influence of Thought upon the body is illustrated by such facts as the following:—A person walking along and struck by some sudden idea frequently stops. It would seem as if the nervous energy, being suddenly and sharply concentrated on the intellectual region of the brain, is simultaneously diverted from that portion of the organ which presides over muscular effort. Again, many persons on hearing a piece of music unconsciously beat time with their feet or hands. Here the nervous energy concentrated, first of all, in the intellectual and emotional region of the brain, gradually overflows this region, and passes out along the nerves that supply the muscles. In the same way many persons, when using the scissors, move their lips in time with the blades. Prolonged and profound thought produces that curious condition known as absence of mind,

which is really impaired activity of the special senses, especially sight and hearing. Of this phenomenon many amusing instances might be cited. Take the following regarding Sir Isaac Newton, who was famous for his absence of mind. On one occasion he invited a friend for dinner, but forgot all about the invitation. The friend duly arrived, and on being shown up stairs found the philosopher deeply immersed in study at his desk, and the table laid for one person. Newton took no notice of the arrival, but remained plunged in thought. Presently the servant entered and laid dinner upon the table. The guest waited for some time, and as Newton made no sign he concluded that the philosopher had already dined, and that the dinner was intended for him. So he proceeded to help himself and presently finished the meal. Shortly afterwards Newton arose from his desk, came over to the table, and surveying the remains of the dinner, murmured to himself—" Well, if I did not actually see those empty dishes I would not believe that I had had any dinner at all!"

The well-known effects of prolonged thought and study in impairing the physical health belong to this part of our subject, and are well worthy of careful attention. The question of over-pressure in schools has attracted much notice in recent years, and claims more than a passing reference.

It is extremely desirable that we should look at this subject calmly and without exaggeration on the one hand or the other. Education is so supremely important to the individual and to the nation that we must be careful not to impede its progress by raising sensational outcries about the ruinous effect of study upon health. On the other hand, the physical well-being of the boys and girls in our schools is the fundamental condition of national weal and prosperity; and we must be most jealous of anything that can be shown to be injurious to that well-being.

What are the facts of the case?

We have ample evidence that severe and prolonged mental effort is not necessarily unhealthy. Professed scholars, authors, literary and scientific workers in general, whose life is one of continuous mental effort, have often been very long-lived. But if to severe mental exertion be added the element of continuous excitement and strain, or if the ordinary laws which should regulate food and exercise be infringed, the consequences of hard study may be most pernicious. The danger in our schools at the present day arises, not so much from study as such (hard work being much better for the brain than idleness) as from the constant pressure of examinations and the stimulation of morbid excitement and an unhealthy appetite for the material rewards of learning. If study be

hurting a child, he will show certain definite signs of the injury. He will complain of headache and langour, digestion and sleep will be impaired, and he will show an indisposition for play and exercise. These points, then, must be our guides, and we may lay it down as a safe and convenient rule, easy of application, that if a child eats and sleeps well, does not complain of headache, and still enjoys his games, he is receiving no physical injury from his intellectual efforts. It need hardly be pointed out that whatever caution is necessary regarding over-pressure in the case of boys, a double measure of such caution is indispensable in the case of girls.

II. The next function of the mind to which I wish to direct attention is Will, of which the influence over the body is extremely important. Let us look first at the influence of the will over the muscles. There are in the organism two sets of muscles—the Voluntary and the Involuntary, the former directing the movements of the hands, feet, arms, legs, etc, the latter controlling the contractions of the heart and the movements of the intestines. The voluntary muscles, as the term implies, are under the influence and control of the Will. The involuntary muscles are not. Take the case of deglutition. Food is conveyed to the mouth by the hand—a voluntary act. Chewing is likewise voluntary, and so is the first

part of the act of swallowing. But once the food enters the gullet it is seized by the involuntary muscles of that organ, passes out of the control of our Will, and is conveyed to the stomach, whether we wish or no. The movements of the heart and blood-vessels, by which the blood is propelled through the body, are entirely involuntary. The respiratory movements are intermediate between the voluntary and the involuntary muscular acts. Ordinarily, respiration goes on without consciousness or effort on our part, but we can, at will, hurry or restrain the breathing up to a certain point. The power of the Will over the muscles can be enormously developed by training. Thus the pianoforte player is largely engaged in acquiring those delicate muscular movements of the fingers, wherein his skill so much consists. The art of the potter, carver, wood-turner, etc., is the result of the continuous application of the will to certain muscular acts. The rope-walker and juggler acquire their astonishing skill by similar means. Perfect command over the muscular system is one sign of a well-trained will, while irregular and fidgety movements show the ill-balanced mind. Hence, the high value put upon a calm and dignified demeanour as an index of important moral qualities. I have read somewhere of a Boston family who were very particular in the selection of

their friends. When a new acquaintance appeared he was made to sit in a certain rocking chair. If he sat quite still he was adjudged suitable for further intimacy, but if he swung his legs about, he was given to understand that his presence was no longer desired. It is a curious law of our nature, that while constant concentration of thought and will upon the muscular system enables us to perform many acts of which we were before incapable—such as playing musical instruments—there are other numerous muscular acts which we perform most efficiently when we do not think of them at all. Take swallowing a pill, for instance. It is quite easy to most people, provided you don't think how you are about to do it, but once begin to analyse the process, and think of the various steps, and the simple act becomes difficult or impossible. Nervousness in public speaking or in singing is due to a too anxious concentration of thought on the acts about to be performed. We succeed better when, instead of nervous apprehension and strained effort, we cultivate a little judicious carelessness on such occasions. The power of the will over even ordinary and common muscular movements may be inhibited by some emotional element. Darwin tells us that on one occasion he went to the Zoological Gardens and placed his face close to the glass of the puff-adder's cage. The reptile

dashed itself against the glass in fury, and Darwin tells us that in spite of his knowledge that the glass was an ample protection to him, he could not resist the impulse to start back. He made the experiment many times and always with the same result. Here the dread of the snake tribe, which is natural to man, was sufficient to hinder the will from exercising its usual control over the muscles.

III. I pass on to notice the influence upon the body of the third great function or faculty of mind, viz., the Emotions. The emotions have each their characteristic physical expression, which they elicit by their effect upon the body. We can tell when a friend is glad or sorry, or astonished or indignant, by the expression of his countenance; or, in other words, by the effect of these emotions upon the muscles, blood-vessels, etc., of his face. "Feeling," says Herbert Spencer, "passing a certain limit, habitually vents itself in bodily action." Let us look at the characteristic physical expression of some of the common emotions. See how under the influence of astonishment the eyes and mouth open, the eyebrows are raised, and the jaw falls. See how shame makes us cast the eyes and head down, while a blush mantles the cheek. Watch the man who is the subject of strong indignation; he contracts his eyebrows or frowns, holds his body

and head erect, squares his shoulders and clenches his fist. Grief makes us cast down the corners of the mouth, while the inner corners of the eyebrows are raised. Contempt is shown by a slight protrusion of the lips, and a turning-up of the tip of the nose. I shall presently explain the meaning of these physical signs, which are at first sight most mysterious. Sir Charles Bell gives the following general law regarding the physical expression of the emotions:—"In all the exhilarating emotions the eyebrows and eyelids, the nostrils, and the angles of the mouth are raised; in the depressing passions, it is the reverse." "In joy," says Darwin, "the face expands; in grief it lengthens." Hence, such expressions as "he grinned from ear to ear," "his face fell," "down in the mouth," which are based on physiological facts. Speaking generally, the physical signs of pleasure are those of heightened vitality; those of pain are the reverse. Thus, compare the rosy hue, sparkling eye, and elastic tread of joy, with the pallor, dull eye, and slow walk of grief. The physical signs of extreme terror are very marked and characteristic. "The eye and mouth open, the eyebrows are raised, the individual either stands motionless and statue-like, or crouches down; the heart beats violently, the skin becomes pale, the hair stands erect, the breathing is hurried and shallow, the salivary glands act badly, and the

mouth becomes dry; there is, perhaps, general tremor of the muscles."—*Darwin.*

Terror has a very potent and prejudicial influence over the body. There is the well-known story of the French nobleman and his jester. The jester was guilty of some fault, and the nobleman, to punish him, determined to put him through a sham trial. So a sham court was constituted, the jester was tried and condemned to lose his head upon the block. The mock execution was carefully arranged, the jester's head was laid upon the block, and the sham executioner stood by, and at a given signal lightly flicked the neck with a damp towel. The joke being thus completed, the bandages were removed from the jester, but on examination he was found to be dead. Terror had killed him.

The same truth is illustrated by the following eastern apologue:—A traveller on his way to Damascus saw a hideous hag sitting by the wayside. He asked her name. "I am the Black Death" was the reply. The hag demanded that the traveller should give her a place beside him on his horse. To this he naturally demurred at first, but eventually agreed, upon the condition that on arrival at Damascus she would only destroy fifty persons. The pair journeyed on to the city, and at the gates the hag disappeared. Next day twenty persons died of the black death, the

second day thirty, and the third day forty. The traveller repaired to where the hag was to be found, and reproached her with the breach of her promise. "I have kept my word" she replied, "and have slain only fifty persons; *the others died of fright.*"

The influence of terror being thus depressing and injurious, we shall easily realise how sparingly this emotion should be brought into play as an instrument of education. We must emphatically condemn the frequent practice of playing upon the fears of the young by superstitious stories; or by the invoking of bogies and bugbears. Those who take such means of controlling the activities of childhood are inflicting both a moral and a physical injury upon the young.

Let us now see if we can offer any explanation of the physical expression of the emotion. This is a subject which has been worked out by Charles Darwin and Herbert Spencer with wonderful ingenuity, but much still remains doubtful, and many of our explanations are only provisional. Take the signs which indicate astonishment: The eyes open wide in order to see more clearly, and possibly detect the cause of the astonishment; the mouth is open to permit silent respiration; the jaw falls, because there is general muscular relaxation. The occurrence of a sudden noise makes

us start, wink, and take breath. Why? We start because we are rapidly putting our muscles into a condition fit for sudden effort, if such should be required. We wink because we apprehend possible danger to our eyes; and we take breath in order to be ready for the effort which the unforeseen alarm may probably render necessary. A horse when frightened erects the head and neck, because by so doing he extends his field of vision. A dog approaching a bird's nest cocks his ears and lifts one of his fore-feet from the ground. He cocks his ears because he thereby increases his power of hearing; he lifts one of his fore-feet because he is thus best prepared for a sudden rush, if this should be necessary.

What can be more mysterious at first sight than that the emotion of shame should produce relaxation of the small blood-vessels of the face, and so create a blush? We blush most readily at remarks about our personal appearance, or when we have been guilty of some involuntary breach of etiquette. We may or may not blush when accused of a serious fault, and it is very important to note that on such occasions the innocent are just as apt to blush as the guilty. There is a strong sexual element in blushing, the blush being much more readily excited by a remark of an individual of the opposite sex to our own. Coloured races blush, the effect being

to render the dark tint deeper. The blind blush. We blush in the dark—a fact that was unknown to Shakespeare. Thus, he makes Juliet say to Romeo—

> "Thou knowest the mask of night is on my face,
> Else would a maiden blush bepaint my cheek ;
> For that thou hast heard me speak to-night."

This is a mistake, and constitutes one of the very few instances in which Shakespeare has fallen into an error of observation. Now, can we give any account of the *rationale* of blushing? I think we can. The common element in all the above cases is self-attention. If the attention be suddenly concentrated on any part of the body it causes a flow of blood to the part. Now, the mind being oftenest directed to the face, the flow of blood takes place most readily thither. But the blush is not confined to the face. It may extend over the neck and shoulders, or even over the entire person. As a curious confirmation of the hypothesis above given, I may mention that in races who habitually uncover a larger portion of the body than we, the blood extends over a wider surface of the person than with us.

IV. I pass on to consider the influence upon the body of the fourth great faculty of mind—Imagination. They err greatly who regard the imagination as an insignificant or ignoble faculty. It is really one of our noblest attributes, by

means of which man transcends the narrow limits of sense and time, and rises to communion with the infinite. Imagination gives the poet his visions, the painter his subjects, the social reformer his ideals. It is not less important to the man of science. "Without imagination" says Tyndall, "Newton would never have invented fluxions, or Davy have decomposed the earths and alkalies." According to Crichton Browne, "Faraday's discoveries must be ascribed to the amazing fertility of his imagination. Through imagination Harvey beheld the circulation of the blood. Darwin has transformed biology by an hypothesis. Pasteur's passage from the facts of fermentation to the prevention of hydrophobia has been a brilliant flight of speculations, and Lister's advance from Pasteur's earlier experiments, to the triumphs of antiseptic surgery, has been a chain of admirably-conceived hypotheses; and in these and, indeed, in all instances of scientific progress, the noteworthy point is that it is imagination which has not only anticipated the conclusion, but given the insight. Facts can only be seen by those who are looking for them, and, as it were, know them beforehand. . . . We wring her secrets from Nature by shrewdly guessing at them, and he who would circumvent disease must take the wings of imagination and anticipate her advance."

The states called up by imagination are intermediate between those excited by the senses, and those evoked by the memory—being, usually at least, less vivid than the former, more vivid than the latter. The pleasures of art are largely due to the imagination. A beautiful picture charms us, not only by its inherent loveliness, but because by its effect upon our imagination it transports us in thought perhaps to the mountains or the ocean, or to some scene of famous incident, or to some great epoch in the historic past. Its influence upon the senses is one thing, its influence upon the imagination is another, and more important thing. The quick brain owes much of the celerity and ease of its operations to the imagination. "A brain that is without imagination," remarks the writer last quoted, "is like a country without roads or railways in which locomotion is laborious and slow." Our pleasures and our pains are largely imaginative, and owe a large part of their intensity to the mental concentration which we bestow upon them. The imagination shows the man, and its operations, if revealed to us, would constitute one of the best tests of character. The influence of the imagination upon the physical organism is very considerable. It is probable that a moderate stimulation of the imagination increases the blood supply of the brain, and promotes the healthy

growth of that organ, while an excessive or morbid stimulation of the imagination probably congests the brain and is hurtful to it. The good effects of hope upon bodily function and health are well known, and hope is a form of the imagination. The culture of the imagination being, then, probably salutary both to the moral nature and to the physical organism, it becomes important to enquire how that culture may be best promoted. There is only one form of this cultivation which is almost universal, viz., the reading of fiction. To this, in moderation, no reasonable objection can be raised, but the stimulus to the imagination from the arts, from painting, sculpture, and music, is of a higher type than that afforded by fiction. It is not only of a higher type, but it is much less capable of abuse, and it is a matter for regret that the reading of fiction should so largely fill the place which can only be adequately filled by a cultivation of the artistic faculties.

Mesmerism, hypnotism, animal magnetism, and electro-biology depend upon the operation of the imagination. As the subject of hypnotism is at present exciting wide-spread interest in this country and in France and Germany, I shall enter into it somewhat fully, but my limits preclude me from going into details, and I must content myself with a general sketch of the

phenomena of hypnotism, and with indicating the explanation of these phenomena which is now generally accepted by scientific men. I may begin by saying that between mesmerism, hypnotism, animal magnetism, and electro-biology no line of distinction or demarkation can be drawn. The word "mesmerism" recalls the name of Mesmer, the famous Viennese doctor, who was one of the first to give these doctrines currency in modern Europe. "Hypnotism" is an expression first used by the celebrated Dr. James Braid, of Manchester, and merely draws attention to the slumbrous or trance-like state which is the most striking feature of these experiments. "Animal magnetism" suggests the hypothesis that some influence comparable to the magnetic current, passes from the operator to his subject—an idea for which there is no foundation. "Electro-Biology" suggests that the phenomena are due to some influence akin to electricity, which is also a pure assumption, unsupported by any evidence. The best term is undoubtedly "hypnotism," as it conveys a distinct idea and does not beg the question of cause or suggest any doubtful explanation. The principal feature of hypnotism is the production of a trance-like state, in which the subject is found to be insensible to ordinary stimulation, but acutely susceptible of any suggestions from the operator. The hypnotic trance

can be produced in either of two ways: (1) By physical stimuli; or (2) By mental stimuli. In the former, which was the method of Braid, and is still the one most usually employed, some means are adopted for fatiguing the senses of sight, hearing, or touch. Thus the subject is made to gaze intently upon a coin held in the hand, or at a bright light, or a revolving mirror; or he is told to listen with strained attention to the ticking of a watch, or the sound of a gong; or touch is stimulated by stroking the skin, especially of the neck and forehead. By any of these means the hypnotic trance may be excited in any good subject; but it is most noteworthy and important that these means are only effective on condition that the individual operated upon is aware of their object. In other words, these various stimulations of the senses are powerless to excite the hypnotic trance, unless we bring to our aid the imagination of the person who is the object of the experiment. The second method is by the employment of purely mental stimuli. This is the mode practised at Nancy by Professors Liébeault and Bernheim. The procedure is as follows:—The subject of the experiment is seated upon a chair facing the operator. The operator now works upon the imagination of his subject by suggesting to him a mental image of the hypnotic state. He gazes intently at the subject for a few

minutes, tells him that he looks sleepy, that his eyes are beginning to close, that his head hangs down, that he cannot lift his arm, and so on. In a good subject this method is quite effectual, and in a short time the hypnotic trance is produced. It is evident in this case that the only possible agent in its production is the influence of the subject's imagination.

The phenomena of hypnotism are very curious and interesting. The following discription is from the *Lancet* :—" Among the most striking features of the hypnotic trance are the subjection of the voluntary muscles to external suggestion, the loss of the power of voluntary motion, rigidity of the whole body on the one hand, or, on the other, that peculiar condition to which the term 'flexibilitas cerea' has been applied ;—various contractures ; the phenomena of imitative speech—the patient repeating what is said to him like a phonograph ; sense delusions of various kinds—hypnotics being made to drink ink for wine, to eat onions for pears, to smell ammonia for Eau-de-cologne, etc. The senses of touch and taste are said to be those most easily influenced. The mucous membranes can be made anaesthetic by suggestion to such an extent that the fumes of ammonia in the nose and tickling of the throat are not felt ; even the conjunctiva can be touched without producing the corresponding reflex. The muscular sense can

also be inhibited in hypnotism, the patient resembling a sufferer from locomotor ataxia. Complete insensibility to pain is exceedingly rare, according to Dr. Moll of Berlin, although it has often been regarded as common. The influence of hypnotic suggestion upon the various physiological functions is a very curious subject, and some of the alleged facts are novel and startling. Krafft-Ebing claims to be able to produce any temperature he pleases in his patients by suggestion. The perspiration and the saliva are said to be capable of being controlled in the same way. Local reddening of the skin, slowing of the action of the heart, are said to be similarly effected. Even more startling statements follow: We are informed that under the influence of hypnotic suggestion blisters can be made to rise upon a patient if he can be made to believe that a blister has been applied to him. Marks like burns are said to have been produced by pressing such objects as a snuff-box, or a pair of scissors to the skin; the patient being told that his skin was being burned. Various bleedings are said to be capable of being produced by suggestion. Wheals, redness, and swellings, are said to have followed the slightest pricks to the skin when the patient had been led to expect them."

The above account sounds very like an extract from Baron Munchasen, or the "Voyage to La-

futa"; but the facts rest on good authority, and are at least substantially true.

Accepting the facts of hypnotism, two questions suggest themselves for solution. Can we account for them on any theory of brain function? And, Are these phenomena capable of any useful application? To the former question we may give the answer supplied by Heidenhain and Mendel, that the phenomena are due to temporary inhibition of the functions of a portion of the surface of the brain. A portion of the brain being, as it were, off duty, certain functions of the organ are in abeyance, while certain other functions are in a state of abnormal activity. The second question is still the subject of vehement controversy. The most extraordinary results have been claimed for hypnotism in the treatment of various painful affections, e.g., rheumatisms, and neuralgia, insomnia, in hysterical paralysis, neurasthenia, in stammering, writer's cramp, and many other diseases. It has even been agreed that hypnotism is capable of being used as a powerful moral agent, and that inasmuch as education consists largely in giving suggestions, we should not hesitate to induce the hypnotic trance in order that our suggestions may acquire all the extraordinary potency which this trance can bestow upon them. Alcoholism, the morphia habit, and many other moral obliquities

have been alleged to be capable of control by hypnotism.

After carefully studying the literature of hypnotism, and actually watching the practice of its professors, I have been led to the following conclusions:—That hypnotism has not yet made good its claim to be recognised as a regular branch of the healing art; that the benefits, while sometimes striking, are most often transitory and illusory; that its practice is attended by considerable dangers, some physical, some moral; and that hypnotism, belonging, as it still does, to that no-man's land, where quackery and chicane hang on the skirts of scientific medicine, should be scrutinised with jealous care, and subjected to vigilant control. Allow me to take this opportunity of condemning in the strongest terms the public exhibitions of hypnotism. As well might we admit the public at so much a head to the operating theatres of our hospitals to watch the writhings of patients under ether or chloroform, as permit the contortions of hypnotised subjects to be the amusement of spectators, and a source of gain to strolling self-styled professors. Such exhibitions are foreign to the spirit of true science, which never encourages buffoonery or stoops to conjuring. They have been forbidden by law in the principal countries of Europe, and I trust the time is not far distant when a similar

enactment will be in force amongst ourselves. If hypnotism is ever to be a real service in helping to lift the burden of disease from suffering humanity, which is still doubtful, its study and practice must be left in the hands of the trained men of science, who can be trusted to extract from it whatever good it is capable of affording, without playing upon the hopes, fears, or superstitions of mankind.

I began by stating that our subject of to-night abounds in mystery. I must conclude by striking the same note. The nature of mind is an unsolved problem which ever tempts us to essay its solution only to baffle our efforts. The materialist who informs us that "the brain secretes thought just as the liver secretes bile," is really using language that has no meaning, while the idealist who thinks he understands all about the inner essence of mind is not less deceived. But if we cannot, in the present state of our knowledge, solve these questions, we can at least examine, and enquire, and define our ignorance. We can take comfort from the Baconian maxim that—*Dimidium sapientiae prudens interrogatio.* We can clear our minds of prejudices, and prepare them for the reception of new light. The progress of the race is largely synonymous with the increasing influence of mind over body. We may fairly hope that as years go on the lower

elements of humanity will pass more and more under the control of the higher, and that intellect and conscience will replace, in a large measure, appetite and passion, as the great motive forces.

# THE FOOD WE EAT.

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NO subject could possibly surpass in importance the one we are to consider to-night. Not only is the individual interested in the question of the relative values and properties of different articles of diet, but our welfare, perhaps our very existence as a nation, depends on the food supply of our ever augmenting numbers. It seems to me that any movement for the amelioration of the condition of the lower and working classes must commence with reforms in the diet of the people. It is very curious that in the United States, as well as in Great Britain, all classes, taken together, seem to spend almost

exactly a half of their yearly income on articles of food and drink. No commonwealth in history has collected social statistics so carefully as Massachusetts, and the result seems to be that all classes of working men, skilled as well as unskilled, spend fully a half of their income on food alone, without taking alcoholic drinks into account at all. Again, Professor Walker, of Yale College, in his splendid book on "The Wages Question" (p. 112), says that Dr. Engel of Berlin, has shown that in Prussia a person with an income of 750 dollars a year spends fifty per cent. of this sum for food. We shall see directly that, taking in the highest and the lowest in Great Britain, a full half of the whole national income goes for food, wine, spirits, and beer. Now it seems to me that the common people can never be taught that thrift and economy which are essential to their saving money, as well as to their keeping money if they had it, while they are obliged to spend a full half of their wages for food. Before there can be any prosperity for the working man he must be shown how he can live, and live far better than he does now, for from one-fifth to one-tenth of the present outrageous expenditure. It could easily be done. All we want is to instruct every girl in the values of different articles of food and teach her to cook decently, and when these girls become

the housekeepers of the nation the thing would be done. But the only way to make any kind of knowledge general property is to teach it at school, and I am afraid it is quite impossible to to do much with the present generation of housekeepers. These will always stick to the only few dishes they know how to cook, and it is totally useless to tell them that *1lb. of cooked haricot beans at twopence*, with a little butter, dripping, or fat of any kind, is *equal in food value to 3bs. of beef without any bone.* No use in telling them that beans, peas, and lentils, when properly cooked, are more easily digested by the great majority of people than beef is, and that after eating an equal weight of these a man feels lighter and less oppressed, as a rule, than after beef or mutton. If you even get the present race of women to try haricots or lentils, the chances are they make such a hand of the dish that the beans are pronounced to be only fit for horses, and never tried again.

I repeat we cannot introduce a reformed diet without teaching the people how to cook it. The great bar is ignorance of cookery. The principal reason why so many of our town dwellers stick to tea and white bread three times daily is that "it is so easily made ready." Then the poor women are often out working all day themselves, and have very little time to practice any little cookery

they know; and this working out of women is greatly increasing the evil, as the girls who go out young to work learn absolutely nothing about cookery or any other branch of housekeeping.

A consideration of these things would incline me to the belief that the remedy proposed a few years ago by Captain Wolff, M.P., is the best one. He proposes to establish public kitchens on a large scale in all our big towns—one for every convenient district—and at all large public works. These could either be established by public companies, or better, by co-operation among the working-men themselves. If one kitchen cooked for say only 1,000 people, the saving would be enormous. The mere saving of fuel, and that effected by making wholesale purchases for ready money in the cheapest market, would amount to £8,700 for 1,000 men in a year.

Even without any food reform, using the present articles of diet, the poorest man who earns wages at all, could have a table as good as that of a wealthy merchant for less than he now gives for stuff which keeps body and soul together, and no more. For there can be no question that the diet of the poor in cities is most innutritious; stunts and dwarfs the children; and keeps the parents in a continual state of low mental and bodily condition. Their half-starved tissues are unable to resist the influence of disease germs

or other causes of illness. Hence consumption and scrofula carry off the inhabitants of large towns, as if a continual plague were present. Hence a fourth of the infants die before they are five years of age, and those who survive have "large city" written in their pasty white faces. Such people have no vigour of mind even to respect themselves, hence they live in dirt and ignorance and most of them never dream of bettering themselves; their constantly depressed and exhausted bodies call for stimulants, hence they also throw away their money on tobacco, tea, and worse than all, whiskey.

Now, I hold it is plain to any sensible man that the elevation of the poor must come from and by themselves; other classes may teach and show them how, but the real work must be done by themselves. With their present careless and thriftless habits no amount of money could enrich them one whit. Were wages doubled and hours reduced there would only be so much more to squander and fling away. There is no royal road to wealth for any class any more than for any individual. If the people who are at present the poor want to be wealthy they must do as the present middle classes, who were poor not so long ago, have done. The road to wealth is as plain as the way to the public house. But Nature gives nothing except in return for work done. If

a man, or a class of men, wants to be rich they must pay the price. What is the price in this case? Simply this: they must acquire habits of industry and thrift; learn to lose neither time nor money; they must learn to hold on to as much of their earnings as they can and strive in every way to increase those earnings. The whole class must be taught and helped to do what those fond of money have done merely from the love of riches. It may be objected that such a determination on the part of the poor would ruin thousands. No doubt it would cause thousands to adopt some other mode of support.

It may be said that if the working men combined to feed themselves at wholesale cost, that thousands of small shopkeepers would be ruined. Not ruined, I would answer, but compelled to become workers instead of being supported in idleness off the workers. Reformers talk of the sins of wealthy idlers;—what about the thousands who live directly on the follies and extravagances of the poor? Are they not the really injurious idlers? The wealthy man is living on money that his father or somebody earned and saved. Has he not a far better right to do without work than the lazy but cunning fellow who scrapes together a few pounds, then drops all work, starts a little shop and lives on his late fellow-workmen? If working men once became a little wiser, ad-

vanced a little in civilisation, so as not to be content to live from hand to mouth like savages, and began to save money, and to go direct to the market instead of to the small shopkeeper, no doubt many classes would suffer; but they would all be classes who deserve to suffer, who have no right to look to their fellows for support without work. The great evil of saving money hitherto has just been this, that as soon as a man has scraped £50 together, he thinks he has no right to work any more. He is a little more knowing, a little more cunning than his fellows or he would not have scraped up the £50, so he turns his cunning to advantage and starts some kind of little shop and ceases to work ever after. But if working men resolved to cease throwing away their money, even in a few months they would be independent of the pawnbroker, the small-trust grocery, etc., and would save money by going to larger dealers and buying for cash.

Just as the poor acquire sense and the characteristics necessary to prevent their wages slipping through their fingers, so will one class of parasites after another come to grief and have to join the ranks of the workers. Men must get rid of the idea that as soon as they have saved a few pounds they should be exempt from work. If all were fairly wealthy the work of the world would have to go on just the same. Man's food and

clothing will always have to be wrung from reluctant Nature who, as we said, gives nothing for nothing. But the workman with even the smallest sum saved would be in a wonderfully more comfortable position than the home savage who saves nothing and is a pauper if he can't work in a week or two, according to his poverty. The workman with savings is independent of everybody just in proportion to his savings. He can choose his employer, choose his market for his various necessities, is a different man in every way. He is in fact a small capitalist who works with his hands to keep up or increase that capital.

In order that such a happy change may come over our country, we think that some such plan as the public kitchen is essential. The meals would be sent out for and eaten at home where a man has a family. Thus the heaviest part of her duties would be removed from the wife. She would have much more time to make the house a real home, to repair her own and the children's clothes, to keep the rooms clean and inviting, to train her own and her children's minds. The man would be deprived of the annoyance of meals not ready, or worse cooked than usual; a tidy hearth would remove his excuse for going to the public-house for comfort after his day's work. Then if his food only absorbed one fifth or sixth of his earnings, instead of a full half, some real

commencement in saving could be made, and the commencement in this is everything. Most men, once they taste the sweets of money in the bank and of being quite out of debt, like the feeling so much that they go on, and as they go on in saving, progress becomes more rapid.

The most repulsive and shocking thing about Socialism is that it actually denounces thrift and industry, and declares they would finally do harm by preventing the circulation of money and diminishing the demand in many trades. The obvious answer to this objection is, that the days of hoarding in a stocking are over. The poor man would put his money in the bank the same as rich men do, and it would there be as productive as any other man's capital until he had accumulated enough to place it in some productive investment, when he would virtually become part proprietor of whatever concern he choose to invest in. Where then would be the prevention of money circulation? As to the decreased demand in many trades; it would only be in the useless and injurious trades. But we have pointed out that a great many fatten on the poor man besides the employer; and I would certainly let all those who now fatten on the follies of the poor join the ranks of the workers without a sigh. Still I quite admit it would be a bad day for demagogues and agitators who now manage

to escape work by flattering and fooling the working-man.

Such then is the immense, the national importance of the study of the best and cheapest forms of diet.

With the population of Great Britain doubling in less than twenty-five years, with a constantly-increasing proportion of that population crowding into great cities, with the large town population degenerating in body and mind in great part through badly chosen and extravagant diet and the barbarous ignorance of cookery among the wives of working-men, surely it is time that an interest in food and feeding was aroused in the public mind. The total income of all the people in the United Kingdom is somewhere about one billion—one thousand million pounds. Half of this, or £500,000,000, is spent annually on food and drink. One quarter of the national food expenditure, or £124,000,000, goes for alcoholic drinks, which are all but useless as foods, not to speak of the gigantic evils of drink. £18,000,000 is spent on tea and coffee, which not only are almost valueless as foods, but which prevent the working classes from taking really nourishing food. Then the great national fallacy that flesh-meat in large quantities is a necessity robs the working-man of his hard-earned pittance, while, according to Sir Henry Thompson, too much

flesh meat is the cause of at least one-half of the diseases of those over fifty in both the middle and upper classes. Flesh costs the nation more than £114,000,000 per annum, or upwards of 1-9th of the total national income. By a food reform, which would benefit all classes, half of this sum might be saved. That we spend too much on flesh is surely proved when we find that bread, potatoes, and vegetables combined only cost the nation £127,000,000. Then, look at £14,000,000 annually actually spent on pipes and tobacco. Surely part of this sum might be saved. The fact is that all classes, from the poorest up, are spendthrifts more or less as regards food, and yet half of the population is semi-starved by food which cannot afford one half the energy required for healthy growth, development, or work. Large classes are starving on starchy white bread, tea, and a little bacon, which costs 2s 7d per head per week, while country labourers can be fully and well fed on potatoes, buttermilk, and Indian meal at 1s 9¾d per week. It is a hundred pities that buttermilk is so much despised and neglected. It is really the cheapest source of nitrogenous matter. It costs at present ¾d per quart, and in summer three quarts a penny. Yet it has been proved by Ritthausen that two quarts supply as much nitrogenous or building food as one pound of beefsteak. Why every working man has not a

pint or a quart of this delicious beverage, as pleasant as claret, to his dinner the year round is a mystery.

We want to convince all classes that nourishing diet, or diet for hard work, is by no means costly diet; in fact, the best foods are the cheap ones. The great County Antrim physician, Dr. Abernethy, used to say to his rich patients, "Live on sixpence a day, and earn it." But, if it comes to a question of expense, a ploughman might be satisfied and fed to the full on a shilling a week. And it is only a knowledge of cookery which is required to make his dishes at such an expense as savoury and toothsome as any other dishes, no matter what the cost. In the days when foodstuffs were dearer than now farm labourers in West Scotland used to be lodged and boarded at 1s 6d per week, with washing thrown in. Dr. Parkes says Scotch ploughmen used to be allowed 2½lb. of oatmeal and one pint of milk daily. This was an enormous allowance of food, and would satisfy a whole family of factory workers, yet at present it would cost about 2s for meal and 11d for milk weekly, as milk is 3½d per quart, and oatmeal 1s 10d to 2s per stone retail. Some years ago Stafford gaol had the lowest death-rate and sick-rate in the kingdom, yet the prisoners were fed at 4½d per day. Then we know that the average wages of the agricultural

labourers in India are 2s 3d per week. Millions of as fine men as are in the world support themselves and large families of children on such amounts. Far oftener indeed the Indian peasant has to support his children and himself on 1s 6d per week.

We give these examples merely to show what can be done by a wise choice of articles of diet, and to prove that in these countries no one need starve, or even be pinched in his diet, if he earns wages at all.

We find that in London and other large towns the working-classes spend from 58 to 62 per cent. of their earnings on food, so that if there is to be a redistribution of wealth of any permanent character, if the poor are ever to be raised and made as comfortable as any other class, we must begin with food reform.

There are only two ways of setting about the matter. Either the children must be taught the relative food values of different articles and how to make agreeable dishes of them at school, or co-operation in feeding and cookery must take place in all large centres of population. As the present generation of housewives is quite hopeless, the common cooking kitchen would seem to be the most feasible plan. Cookery classes are all very well as far as they go, but the pity is they go so short a distance. All the people they teach

is only like the drop in the bucket, imperceptible. But by companies formed to open extensive kitchens in each district for the preparation of all kinds of really cheap meals to be carried home and eaten there the working man could have a table equal to that of the rich at less than he now pays for his ill-cooked, semi-starvation fare. The saving in fuel by using one fire instead of a thousand, and in making wholesale purchases, would alone do this without any reform in diet whatever. But if flesh were only used for its proper and natural purpose—viz., to give its smell, taste, and savour to all dishes requiring it —and lentils, peas, beans, maize, the various cereals, and vegetables were made the groundwork of the dishes, the saving would be enormous. Thus the poor man's house, which is totally unsuited to cookery, would be relieved of the continual turmoil and trouble of getting meals ready to the miuute. Thus the working-man would be relieved of the temper-trying ordeal of waiting for his dinner or taking it cold, or, still worse, of bearing in silence to see his money squandered on trash, which, made still worse by his wife's ignorance of cookery, is too often an excuse for stepping into the public-house to supplement it by a pint of ale or porter. The wife, too, would be relieved of the heavy half of her duties in life, and if of an industrious turn she

would have more time to make and keep the house clean and neat, repair the children's clothing, keep herself and them neat and respectable, and the home a home in reality, into which a man could come at the end of his day's work with some feeling of pleasure.

There can be no doubt this would prove a successful rival to the public-house in numberless cases. And suppose a family getting really good and sustaining food for from one-fifth to one-tenth of present cost. A working man could really begin to save, to become a small capitalist, and to rise rapidly in the social scale. Special kitchens could be connected with all public works, so that an end would be put to the wretched system of carrying out the dinner, a little can of tea and chunk of white bread and beef or cheese, on which so many have to do hard work. Where the wife, and perhaps the children, have to work out, the getting rid of the cookery would be an inestimable boon. The women of the family would have some little time to make the house into a home, the majority of such houses at present being almost unfit for human beings owing to want of attention and cleanliness.

This very fact of the women working out to such an extent is one of the very reasons why some change is bound to come shortly. The workmen's wives have always been shockingly

ignorant of cookery, but, now that they have to work out, girls fail to learn even the little their mothers knew. So the evil is growing every day. The modern workgirl, in whatever sphere, mill-girl, wareroom-girl shop-girl, etc., when she marries, is totally helpless, and, as she has often to continue her labours, the home is no home, and the meals no meals.

Under such circumstances the working classes can never be elevated to any great extent; but waste, want of all approach to home comforts, uncleanliness of person, clothing, house, and semi-starvation will continue to drive them to intemperance and self-neglect even were their wages doubled. Even at present the great want is not money, but thrift, self-respect, home comforts, proper food, and, still more, proper cookery and serving of meals, which serve to distinguish man from the lower animals and the higher from the lower classes. Skilled artisans and foremen have at present far larger incomes than the rank-and-file of professional men, clergymen, army surgeons, chaplains, clerks, and small business men; and yet how different their homes! If working men had decent homes and food they would commence at once to rise in the scale of culture and refinement, and they would begin to exercise foresight, thrift, and industry, which are alike necessary to make people wealthy, or to

retain the wealth when they have it. Unless working men were greatly changed and advanced in civilisation the division of all the money in the world would only do them evil. It would only be so much more to squander and drink.

Just look at the immense classes that live and fatten on the extravagance and follies of the poor! Of course, if the poor became thrifty and careful like the middle classes all these people would be reduced to poverty or have to take to useful occupations. But surely this would be the fairest and justest way of redistributing wealth. Let the working classes learn the truth that "He who can hold what he has can get more," and they will find no difficulty in becoming wealthy. Of course that does not mean that the world will ever go on without work. But there is all the difference in the world between a workman who is absolutely without savings and one who has even £100 in the bank. A working man with a little capital could choose his employer, could face bad times, want of work, sickness, etc., instead of being ready for the workhouse when he misses a week's pay. We know many families where the joint income amounts to £250 or £300 per annum, who live like pigs, who never have a decent meal, a clean table to take it off, or a clean coat to go out in. Instead of that they owe the neighbouring grocer as much as he will allow

them, they pay almost double prices by buying in trifling quantities, they never have a shilling of ready money, too often the Sunday clothes are got out of the pawn on Saturday and go in again on Monday. Instead of having a moderate capital in the bank they are always a week or a fortnight behind according to periods of payment, and would be a month if they could. Yet the money that slips through their unthrifty fingers would enable the clergyman to live in comfort as a gentleman, and to educate a large family as ladies and gentlemen.

Will anyone say it is more money these people need! Is it not rather more civilisation? Savages are all penniless. In a state of civilisation the wisest of the people rapidly accumulate property. The unwise, vicious, and ignorant continue to live from hand to mouth like savages. They have lagged behind in civilisation. Their ranks are joined by people from every rank, even up to nobility, who are uncivilised in their characteristics. Baronets are driving cabs in London and herding sheep in Australia. If a man has the necessary characteristics he accumulates money no matter where placed or how paid for his work, as is well seen in the Jewish nation all over the world.

If a man has the characteristics of a savage, idleness, want of prudence, foresight, thrift, industry, then he will become poor no matter how

he commenced. If he has a fortune left him he will soon have none, no matter how large it was. What we want to do to help the lower classes to rise in the social scale is to teach them this, to advance them in civilisation, and to this end we must begin with food reform. Let the working classes keep most of that £124,000,000 spent in drink every year; a half of that £18,300,000 they spend on tea and coffee; three-fourths of that £114,000,000 they spend on flesh every year; a half of that £14,000,000 they spend on tobacco and pipes, and at compound interest a great part of the wealth of the kingdom would soon be in their hands. Yet no one would be injured or could complain except the classes who fatten on the extravagance and folly of the poor, which are relatively far greater than the extravagance and folly of the rich—that is, the follies of the poor swallow their all, while they only swallow a portion of the income of the rich. No doubt if the working classes held their money instead of flinging it away it would be much harder to make fortunes, especially off brewing, distilling, theatres, comic papers, pawnbroking, etc., but that would be a benefit to society instead of a loss.

*What is a Food?*—A food is anything which provides for the growth, repair, or building up of the body, or which furnishes it with heat or force. The human body has often been com-

pared to a locomotive engine, and the parallel is very good if we imagine that the rods, wheels, joints, every part of the engine is repaired and kept in good order every time the engine is supplied with coal. For the human body has the power of repairing itself as it goes along.

*Uses of Food.*—We gather the uses of food from the above. To provide for growth and repair of wear and tear; to keep the body at a temperature of 98¼ degrees Fahr., and to furnish extra heat, which by some wonderful process can be converted in the body into the various forms of force—nervous, muscular, secretory, etc. Oxidation is the term for the chemical union of oxygen with other bodies. When it takes place briskly, it is attended with heat and light, and we call it "burning." In the body oxidation occurs slowly, the smoke is given off by the lungs; plenty of heat is formed and given out, but no light. Heat and force are different forms of the same thing and bear a definite relation to each other. So much force or power to do work can be got from so much heat, just as in an engine. Professor Joule, of Manchester, discovered the exact relation between them. He found that the heat necessary to raise the temperature of 1lb. of water 1 degree Fahr. was equal to the force required to lift 772 lbs. 1 foot high, or 1 lb. 772 feet high. The daily work done in the body is

equal to 3,400 foot-tons, or would raise such a weight through the distance of one foot. In other words the force generated in 24 hours in a man's body would lift one ton weight 3,400 feet in the air. Four-fifths of this force is expended in the production of heat to keep the body warm, as heat is always escaping from our bodies, notwithstanding the efforts we make to keep it in by woollen clothing, which is a very bad conductor of heat. To give a better idea of the amount of heat produced in the body, we may say that it would raise it to the boiling point in 36 hours if the clothes were perfect and suffered none to escape. It would also raise 62 lbs. of water from the freezing to the boiling point in 24 hours. The remaining fifth of the force produced in the body, daily, is divided into two-tenths. One tenth is converted into the internal work of the body—the breathing, circulation, formation of secretions, digestion, brain and nerve force, etc. The last tenth is available for external work, as walking, working at anything with the hands, studying, etc.

*Perfect Food.*—A perfect food is one which contains everything we require in proper proportion. The only two samples we have are compounded by Nature, viz. : milk, which provides the vital force and the building material to the young of so many animals, and the egg, which,

taking the shell into account, forms the entire young bird. If the shell be examined after hatching is over, it will be found that it is reduced to a mere skin or membrane, the lime-salts being entirely removed to form the bones and feathers. Still, the egg is deficient in heat-forming materials, the heat during the hatching period having to be supplied by the mother's body. Of our ordinary foods bread comes nearest to a complete or perfect food. Oatmeal porridge and new milk also approaches a perfect or typical food closely. The egg is supposed to be highly nitrogenous or flesh-forming in its qualities, as the white contains little but albumen and water, and the yolk albumen and oil. So it is a good food but just let us compare it for a moment with oatmeal, and we fancy we shall surprise most people who are ready to pay a penny to twopence for an egg. The fact is that all animal matters contain such a large percentage of water that some of the grains, peas, etc., quite equal, and sometimes far surpass, the animal articles as to nitrogenous matter, not to speak of the large quantity of starch or heat-forming matter to be found in the grains. The entire egg, yolk and white together, contains 14 per cent. of its weight of albumen, 11 per cent. of oil and fat, 1·3 per cent. of mineral salts, and *71 per cent. of water.* Now turn to oatmeal. Good oatmeal

contains also 14 per cent. of vegetable albumen, 77·8 of fat and starch, 3 per cent. mineral salts, and only 15 per cent. of water. Of the 77·8 fat and starch 6 per cent. is actually fat in the meal. So the case stands thus: A good egg weighs two ounces. Two ounces of oatmeal actually contains the same amount of albumen, more than half as much fat, twice as much mineral matter, and, besides, 65 per cent., or about an ounce of starch, which goes to form both heat and force. So a large egg, costing twopence, is actually not by an ounce of starch as good as two ounces of oatmeal, yet *two ounces of meal would only cost one farthing.*

These are the points working people should be taught.

Different articles of food provide the materials wanted in varying proportion. This is why instinct teaches us to obtain our supplies from so many sources. Many national and other diets are unbalanced and faulty, and some cost quite too much money, while some combine both faults. Most faulty diets could be put right and made highly nutritious by a very slight change; and often a diet could be made twice as nutritious and twice as cheap if only housewives could cook the dishes recommended so as to make them tempting. The various cereals—peas, beans, etc.—require a little knowledge of cookery to make them palat-

able; and the ignorance of cookery, at present so universal, is the only reason such articles are still neglected or disliked. Still there is another point for study. All populations, at least in temperate climates, who live almost exclusively on vegetable articles have a great longing for flesh diet, which will always drive them to obtain it at whatever sacrifice. To meet this craving without undue expense, also requires to be taught. The proper place of flesh in man's diet is to give its taste, smell, and savour, to vegetable dishes. Neither rich nor poor, as a rule, should employ it any further than this. To explain my meaning, let us compare the savoury and highly nourishing pea soup with a mess of peas alone; a piece of bacon and some fat make all the difference. Again, contrast beans and bacon with plain beans, cabbage and bacon with plain cabbage, or potatoes and meat (Irish stew) with plain potatoes and salt. These compound dishes are the ones all classes ought to be taught to make and use. Any of the dishes we have mentioned would supply a man with strength for the hardest work, and yet he would not be bound to an untempting or flavourless diet. His meal would be just as savoury and tempting as that of the rich man. Or, suppose a rich family are going to have a leg of mutton for dinner, let them take only a fourth of the usual quantity of mutton and add round about it two

quarts of well cooked haricot beans. It will be found that with the flavour of the mutton the beans are just as good as the flesh to taste, while they are much more strengthening. Yet the beans boiled alone, although very strengthening, would be rather untempting fare. Such a mixture of vegetable matters with flesh for flavouring is the secret of cheap and sustaining yet very savoury feeding.

If we enquire at the workers in large towns why they stick to such stuff as tea and bread constantly, they will tell you it is because it is so easily made ready, that their wives are out working too and have no time to make ready anything else, etc. Now this entirely arises from their want of knowledge of a very little cookery. Indeed, even without any great knowledge of cookery, if poor people even thought of the matter they could devise something far better than tea and white bread for breakfast, and the remainder carried to the work for dinner. How could children grow, or men and women maintain their health on such a poor diet constantly? No wonder the factory workers are degenerating into sickly dwarfs. But then, the very classes who have most need for thought and foresight, seem quite incapable of it. At all events, as the poet says :—

"Evil is wrought by want of thought as well as want of heart.'

Some years ago, Dr. Newett of Ligoniel, pointed out to the mill workers how they could remedy the constant living on tea and white bread, but I never heard that his very creditable exertions produced any effect. He pointed out how they could have a nutritious *meat* soup instead, at the nominal price of 5d. for three quarts. This really good soup could be prepared at home after hours in the poorest house without trouble, and as it would keep a few days, three times a week would give them soup every day the year round. So that when we look into the matter there is really no excuse for the constant tea meals which prevent children growing, and hardly keep body and soul of grown people together, thus promoting a resort to intoxicants to restore the feeling of well-being were it only for an hour. With regard to the tea diet stopping growth of children, Dr. Ferguson, an Inspector of Factories, made prolonged and careful experiments on factory children which showed that if they had milk for breakfast and supper, instead of coffee or tea, they grew four times as fast between the ages of thirteen and sixteen years. If large children like these require milk so much, what about the infants and young children? The fact is that multitudes of these die if deprived of milk as the principle article of diet. The soup recommended is made as follows:

To make 3 quarts and half a pint, take half a pint, by measure, of peas, 3 ozs. of oatmeal, half a pound of cheap neck beef, 3 teaspoonfuls of salt, a teaspoonful of pepper, a little parsley and chives. The peas should be steeped in cold water for nine hours, the beef cut up into small pieces, the oatmeal put into a bowl and mixed with a little cold water. Then beef, peas, and meal should be put into a pot containing 3½ quarts cold water, and the pot covered and placed on the fire. After boiling half an hour, the vegetables finely cut up, and the salt and pepper should be added. Boil another quarter of an hour—in all three quarters of an hour. The soup should then be poured into any delf vessel for use. It can be re-warmed and served next day or the second day, and could be carried to the works and there warmed instead of the tea. As it is required to keep, we have not spoken of cabbage, parsnips, turnips, carrots, etc., which would greatly improve it if it were to be used next day. But leeks and onions would not turn sour in two days if agreeable. The coarse neck beef is very cheap, but is just as good as any other for soup. A good soup could even be made from beef bones, which are to be had almost for nothing. Making such a soup would cause no more trouble than making tea. It could be done at night in the poorest home, and three makings per week would

provide it every day. This would be a great improvement in diet, and if the workers would only boil a pot of potatoes after coming home and have them, and the soup for supper, a change would soon be observable in their appearance. Even one nourishing meal per day makes a wonderful difference. The great value of the potato is that it supplies the place of fresh vegetables, and during the great part of the year no other vegetable is available. No one can be healthy without the daily use of some fresh vegetable. This is partly what is amiss with the factory workers, by having neither soups nor potatoes they are deprived of vegetables. The introduction of the potato was a great blessing to Great Britain, as before its use England was ravaged by scurvy, because during the greater part of the year there was no fresh vegetable to be had. The potato has been railed at, and all the miseries of Ireland traced to the national diet, but this is all nonsense. The same amount of ground yields, perhaps, more food-stuff under potatoes than under any other crop. When the potato was brought to Ireland the people liked it, and it was too much relied on. As it provided abundant and cheap food the population became very great; then when their only food supply failed in '47 of course the famine was dreadful. We are told the potato has 74 per

cent. of water, but lean beef has 72, and human blood has 75. Then we are told that it has only 2·1 per cent. of nitrogenous matters or flesh formers, and that it is principally valuable for its starch (23 per cent.) or heat formers. But such people do not tell or do not know that the heat formers are also the principal force givers, and that the potato has 7 per cent. of salts essential to healthy blood. It is also said that a man would require to eat 11 lbs. of potatoes to do a day's work on, but they forget that no Irishman ever lived entirely on potatoes. They always have at least buttermilk in addition, and potatoes and buttermilk is about the cheapest and best national diet ever invented.

The supply of nitrogenous matter is drawn from the buttermilk, of which two quarts are equal to 1lb. of beef so that if the Irishman had a little flesh meat to give taste and flavour to his dish of potatoes no better diet could be imagined. Meat and potatoes mixed—Irish stew—is a most inviting dish. The only fault of the potato is that it is deficient in fat (2 per cent.), so that dripping or the oily herring is usually added when procurable.

The fact is that some years ago, a Royal Commission enquired into the diet of the agricultural inhabitants of England, Ireland, and Scotland, and their verdict was that the Irishman

got the best food of the lot at the lowest price, and that he even got better value for his money than the Scotchman. Oatmeal and milk were, until lately, the national diet of Scotland, and, next to the Irish, was one of the best and cheapest in the world. A good deal of cabbage, or "kail," was added, and very necessary too, as a fresh vegetable to keep the blood pure. As we have seen, oatmeal is a very powerful food, being far better weight for weight than eggs. It is somewhat deficient in fat, although it contains 6 per cent., but the want is supplied by the milk taken with it. The English national diet (labourer's), bread, cheese and beer is not nearly so good as either Irish or Scotch.

You all remember Lord Elibank's smart reply to Dr. Johnson's definition of oats. Johnson declared that oats was a grain that was given to men in Scotland, and to horses in England. "Well," said Lord Elibank, "and where will you find finer men and finer horses."

It is nothing short of a national calamity that the inhabitants of all large towns have abandoned the simple diet of the country people and taken to the white bread and tea. Bread contains about 51 per cent. of carbonaceous or heat-formers, 8 per cent. of nitrogenous or flesh-formers, 44 per cent. of water, and 2·3 of mineral salts, so that it is about 2½ times as valuable as

the same weight of potato. As to the tea, we have nothing to say against it in itself, except for growing children. Its fault is that it prevents other and better food being taken. Then variety in diet is one of the most useful points, yet what could be more monotonous than constant tea and white bread. We have alluded to the absence of all fresh vegetables in this large-town diet. The loaf is also very deficient in fat, having only 1 per cent. which is the reason we like butter with it. Compare it, as to fat, with oatmeal with 6 per cent., and Indian meal with 8. This brings us to say that Indian meal and other stuffs made out of maize, such as hominy, cracked wheat, mush, and many others beloved of Americans are sadly neglected in this country. All these need to be both palatable and digestible, is prolonged boiling or other cookery. The only difference between Indian meal and oatmeal is that oatmeal has more nitrogenous matter, while Indian meal makes up for that by 2 per cent. more fat and 3 per cent. more starch.

*Quantity of Food required daily.*—We can easily ascertain how much food is required by observing how much weight and the nature of the material a man's body loses daily. A man of 11 stone weight loses daily about 40,000 grains or 6 lbs of water, and 14,500 grains or over 2 lbs of solid matter daily. Among the solids lost are

4,000 grains of carbon or charcoal, 300 grains of nitrogen (a gas), and 400 grains of mineral matters. These losses take the shape of 2 lbs of carbonic acid gas (containing $\frac{1}{2}$ lb solid carbon or charcoal and $1\frac{1}{2}$ lbs of oxygen gas), and 10 ounces of water by the lungs, nearly 2 lbs of water by the skin, $4\frac{1}{4}$ lbs of water, urea, uric acid, and nitrogenous matter by the kidneys, and 6 to 8 ounces by the bowels; so that the blood, of which there is only about 12 or 14 lbs, loses more than half its weight of material daily, 6 lbs of this being water. But the body is composed in great part of water, as a man of 11 stone consists of 88 lbs of water and 66 lbs of solids. A man passes his own weight of food and drink through his system in fourteen days. We may fancy the fasting men have disproved these statements, but that is not so. A fasting man takes his 6 lbs of water or 5 pints daily as usual, and in his forty days he generally loses 36 lbs or nearly 1 lb daily; of course he does not lose so much as a man who is fed, as all his vital machinery is working at the lowest rate and he does no work.

*Uses of Food.*—The uses of food are to supply the constant waste going on, and, in the case of children, to provide extra material for growth and development. But, it may be asked, what is the meaning of this daily passing of 8 lbs of matter through the human machine? Well, in

the case of grown persons it is that the materials given may undergo combustion and thus provide heat which the body can turn into force. This force is necessary to keep the body at its healthy natural temperature, without which life could not go on; also to supply the work necessary to life within the body, as circulation, respiration, and to afford force which can be turned to external work. A small part of our food goes to renew worn out portions of the body. All the tissues of the body, except fat, contain nitrogen, so nitrogenous matter is necessary to repair every part. But it should be remembered that there is far more carbon in the composition of the tissues of the body than nitrogen, which shows the absurdity of limiting the name flesh-formers to nitrogenous articles of diet.

*Supplies to the body.*—The supplies come to the body in the shape of the various articles of food, as, unfortunately, the raw material, the carbon and the nitrogen, are of no use to us in this state.

A steam engine can get its carbon out of coal; and Professor Rodgers of Washington says 1 lb of coal has within it the dynamic power equal to the work of one man for a day.

Then four-fifths of the atmosphere consists of nitrogen, yet although we are constantly drawing it into our lungs we cannot make use of it. Our supplies come then as follows:—

| | | | |
|---|---|---|---|
| Solid dry food, | - | 8,000 grains | = 1 1-7 lbs. |
| Oxygen, | - | 10,000 ,, | = $1\frac{1}{2}$ ,, |
| Water, | - | 36,500 ,, | = $5\frac{1}{2}$ ,, |
| | | 54,500 grs. | = over 8 lbs. |

Our $1\frac{1}{2}$lbs. of oxygen is contained in 2,600 to 3,300 gallons of air which we draw into our lungs daily. This air loses one-fifth of its oxygen=100 to 130 gallons of pure oxygen, weighing $1\frac{1}{2}$lbs., and as to the purity of this most essential part of our food, we should be even more particular than as to that of the food we eat.

*Subsistence Diet.*—A man doing no work, even confined to bed, requires 1-150th of his weight daily of water-free food, of this 2 ounces should be nitrogenous matters; $\frac{1}{2}$ ounce fats; starchy matters, 12 ounces; and mineral salts, $\frac{1}{2}$ ounce= 15 ounces.

*Diet for Hard Work.*—A man at hard work requires, in addition to the above subsistence diet, a quantity of matter principally carbonaceous capable of giving the required force. Fats are best for supplying heat which can be turned into force; nitrogenous food stuffs next, and starchy or sugary matters last. The proportion is 1 part fat=2 parts lean meat or=3 parts starch or sugar. In calculating the carbonaceous value of a food, fat is calculated as starch, as above. For hard work, then, a man requires 1-100th of his weight of

water-free food; nitrogenous, $4\frac{1}{2}$ ounces; fat, 3 ounces; starchy, $14\frac{1}{2}$ ounces; and mineral salts, 1 ounce=23 ounces. But there is so much water in all our usual articles of diet that we may almost double these quantities, 23 ounces water-free food=60 ounces as we find it.

*Water in Food (Per Cent.)* It may surprise some to learn that butter contains 15 per cent. of water; rice, 17; ship's biscuit, 8; wheat flour, 15; cheese, 36; bread, 44; beef, 73; eggs, 74; potatoes, 74; salmon, 78; vegetables, 86; milk, 86; human milk, 89.

*Classification of Foods.*—1. *Nitrogenous Flesh-forming, or Building Foods.*—Examples:—Lean meat, vegetable albumen, curd of milk, and cheese.

2. *Carbonaceous, Non-Nitrogenous, Heat-Forming, Respiratory Food.*—This class must be sub-divided into the hydro-carbons or fats and oils of vegetable or animal origin, and the carbo-hydrates or starchy anylaceous, farinaceous foods, such as bread and all grains, starch, sugar, treacle, honey, gum, etc. But bread and all grains also contain a great deal of nitrogen. Most food stuffs are put in the nitrogenous or non-nitrogenous class according to their leading ingredients; so, as bread and grains contain more starch than nitrogenous matter, they are put among the non-nitrogenous foods. The difference

is very marked between the hydro-carbons or fats and the carbo-hydrates or starchs. The first have more hydrogen than would be required to join with their oxygen to form water, consequently their hydrogen is ready to combine with oxygen in the body and so give out great heat. In the carbo-hydrates the hydrogen and oxygen are in proportions to form water, so there is less heat from them during combustion.

3. *Mineral Food.*—This is also building food. Examples:—Common salt; always present in every tissue and fluid of the body. Salt gives soda for bile formation, and chlorine to make hydrochloric acid for the gastic juice. Another great use of salt in the system is to enable substances to enter the blood, and to enable them to pass out again when they have become waste matter. Other examples are, bone earth or phosphate of lime, carbonate of lime, iron, sulphur, phosphorus, and many others in small quantity. They are found in all articles of food, so that we always take lots of mineral matter unconsciously; and so they do not require much discussion or attention on our part. Human milk contains 2, cow's milk, 7; beef and mutton, 2; poultry, 1·2; bacon, 1·3; cheese, 4 to 5; butter, 2; eggs, 1·5; fish, 1·2; wheat flour, 1·7; beans, 3·6; bread, 2.3; potatoes, 7; and vegetables, 7.

4. *Water.*—As essential as air or any other

food. It is required to dissolve and get our food into the blood, and afterwards to get it out again when it is done with and become waste. In this it is greatly aided by salt. So that water is one of the most essential foods. It is also a building food, as it forms three-quarters of the blood and tissues generally, even taking in the bones.

*A Man will not Live on any one class of Food.*—A man or animal, as the dog, can live upon flesh, certainly; but that always contains a certain about of fat (five per cent). But neither man nor dog will live upon pure albumen, the nitrogenous matter of flesh. Neither will they live on fat alone, starch alone, sugar alone, etc. All the different classes described must enter into a diet on which a man can live any longer than he could on water alone. South American hunters can live principally on flesh and water, but they have a great craving for anything vegetable, which causes them to dig for roots, etc. The flesh and water supplies all but the starchy or sugary class, and the roots supply some starch. Living principally on flesh is very wasteful physiologically, as when we eat enough to supply the 4,000 grains carbon required we have taken four times more nitrogen than we require. This is of no service in the system, and has to be removed by the kidneys as waste matter. Thus the system has the labour of digesting it and

making it fit to enter the blood, and also the labour of throwing it out again. While a man is young he can go on eating more nitrogenous matter than he needs, but after middle life the constant efforts of the kidneys to keep the blood pure by removing waste nitrogen causes the kidneys, the bloodvessels, the liver, and afterwards the heart, all to become more or less diseased. Thus is caused a great deal of the chronic diseases which affect people after fifty.

*Folly of naming Nitrogenous Food "Flesh Formers."*—We now see the folly of restricting the name of "flesh formers" or "building foods" to the nitrogenous class. Because water is also a building food, so are the mineral salts, so are fats; as no healthy tissue can be formed in the absence of fat. The only foods that are not flesh formers are the starches and sugars.

*Liebig's Mistake.*—Another folly is to term fats and starches "heat-formers," as if that was all they could do. This was Liebig's mistake, and we are suffering from its effects yet. It is now known that most of the force, as well as most of the heat, come from the fats and starches. The system can certainly split up nitrogenous food into fat and urea, the fat being burned to produce force, and the urea thrown out of the body; but this process is wasteful of energy, and throws too much work on the kidneys. The

effect of Liebig's mistake was to make people fancy that all their strength came from nitrogenous matter, and in particular from flesh meat, and so to encourage the British in their already too great love for that form of food. The facts of the world around might have taught them better, but people are easily persuaded of what they wish to believe. They might have observed that horses, etc., can do very heavy work on vegetable diet, but if this argument is met by the reply that they are formed differently, so as to do best on vegetarian diet, then the history of the human race might have kept them right. The splendid races of Northern India live upon rice, millet, beans, and other grains. The wrestlers of Japan attain a strength and size not often seen in Europe on rice and butter. The Roman legions conquered the world on barley, and barley which was very badly ground in little hand mills the soldiers carried with them. The Roman gladiators and all the athletes trained for their various contests on barley. Surely no people ever displayed more strength, activity, and courage than these practical vegetarians. Then look at Scotland. No country used less flesh meat in the old days, when they gave such constant trouble to their beef-eating neighbours, the English. Scotchmen not only cultivated literature on a little oatmeal, but marched and fought better

than almost any people ever did with only the meal bag by their side. Too often the "brose" was not even cooked, but the oatmeal was simply stirred up with some cold water and eaten raw. We need not occupy time with further examples; the fact is self-evident that men can be supported in the highest possible condition of body and mind on grains and fats alone, without resort to flesh.

*Diet used in Training.*—The fact that prize-fighters and others training for contests of strength and endurance in England were in the habit of living principally on half-raw flesh-meat, still further confirmed the people of these countries in their mistaken idea that the greatest strength was to be obtained from flesh. There is no doubt that the trainers' experience has guided them right in this matter, and that a diet composed principally of lean flesh gets a man into condition more quickly than any other. But because flesh or a highly nitrogenised diet from the more powerful grains is the best for training it does not prove that it is the best for continued hard work. To explain the matter we must refer to some other effects produced by nitrogenous diet, whether animal or vegetable. The presence of nitrogenous matter is, first of all, necessary to the digestion of other classes of food; but this remark would hold of other kinds of diet. Fat

is necessary to the digestion of all other kinds of food; so is water; so are mineral salts. Secondly, the presence of nitrogenous matter is necessary to insure the combination of the other food elements with oxygen and to the production of force. No physiologist denies the absolute necessity of nitrogenous matter in every meal. Nothing else can replace it. Without nitrogen the man will speedily die. Indeed fed on fats and starches only, or on fats, starches, mineral salts, and water, the man would die almost as soon as if kept on water alone. It seems that if an extra quantity of nitrogenous matter be present that oxidation and tissue changes and force production go on at an increased rate.

Then again, as Professor Haughton of Trinity College has insisted, there is a difference of the force productions of nitrogenous matter derived from flesh and that derived from vegetable sources. Dr. Haughton instances the tiger and the deer as examples of the flesh and the vegetable feeder. The flesh feeder can free his energy more speedily and in greater amount at a time than the vegetable feeder. For instance in capturing his prey, the tiger makes several terrific bounds or springs, discharging immense force in a few seconds of time, but he could not keep this up for any great length of time. If he misses his prey after a few springs he retires defeated. On the other hand

the deer can keep up his enormous speed for a long time, and if he escapes the first rush of the tiger, is perfectly safe, as he can easily beat him in a race.

For this reason Dr. Haughton thinks flesh feeding best in athletic training, as for a boat-race. For in a boat-race what is wanted is the capacity for exerting the full strength for a few minutes only. The actual work done in a boat-race is trifling. Rowing a mile at racing speed involves an expenditure of force equal to 18·56 foot-tons (MacLaren), while walking one mile on the level is equal to 17·67 foot-tons, so that we see it is not the strength required, but the ability to give out this strength quicker than the other crew which wins or loses. As usual it is the pace that kills.

But to go a little deeper into the subject, let us look at what is wanted when a man goes into training. First of all, he has usually one, two, or more stone of fat which must be removed to give him his full lung power, for fat deposited anywhere, outside or in, is a cause of short breath just in proportion to its amount. The man in training also wants all his muscles renewed as far as possible, every fibre nourished up to its utmost capacity. So anything which will cause great renewal and change of tissue will favour his ends. By eating more flesh than his system requires

oxidation is brought to its highest point; and so with the hard work, which still further promotes tissue change and the taking in of oxygen, his fat is quickly consumed, burnt up by the great amount of oxygen taken into his blood and turned to carbonic acid and water, which are thrown out of the system by lungs and skin.

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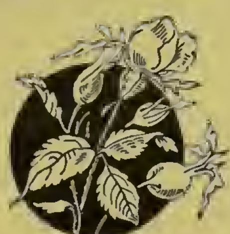

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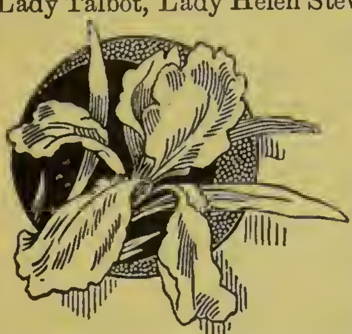

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